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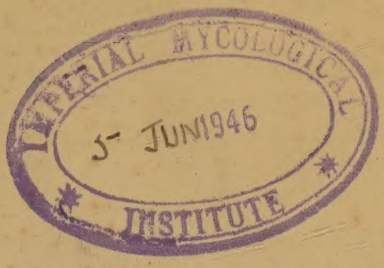

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QUEENSLAND

REGIONAL EXPERIMENTAL STATION, BILOELA.

PROGRESS REPORT FOR THE 1944-45 SEASON.

Introduction.

A comprehensive plan of reorganization of the Queensland Department of Agriculture and Stock was implemented this year, part of the plan providing for the establishment of regional experiment stations where investigations relating to both plant and animal industries may be conducted. As the Cotton Research Station at Biloela is well located to serve a large section of country lying inland from the Coastal Range, in which cotton, grain sorghum and cereals for grain and hay are produced in conjunction with dairying and pig-raising, it has been included in the series of regional experiment stations. Cotton will still occupy the major place in the programme of investigations that will be conducted at this centre, but more comprehensive work than has been possible in the past is contemplated in the other crops that are under investigation at Biloela.

This progress report on the cotton investigations conducted at this Experiment Station during the 1944–45 season has been prepared from the reports submitted by the same officers as were responsible for carrying out the work in the previous season.

Meteorology.

The rainfall from June 30th, 1944, to July 1st, 1945, totalled 23·11 inches compared to the 22-year mean of 27·95 inches over the life of the Station. The total rainfall for each quarter of the crop season was subnormal, especially from January onwards, during which period a deficiency of over 5 inches was experienced. The year's rainfall was characterized by sharp storms—47·8% of the total, or 11·03 inches, falling at the rate of 0·75 inches or over per hour. All of this torrential type of rainfall occurred during the crop season and during one storm at mid-November, yielding 2·59 inches and accompanied by severe hail, rain fell for 15 minutes at the rate of 5·7 inches per hour.

Temperatures may be described as being above normal for the season except during a sudden short period of cool weather in the third week of October, when the latest frost in 20 years occurred, in January, and again in the third week of May when the first killing frost of the autumn was experienced in an abnormally cool spell.

Agricultural Practices.

Past experiences have indicated that planting at the end of September or during October increases the prospects of obtaining satisfactory yields. Crops planted during this period are normally

ready for their first harvest during March, their second harvest during May, and the " clean up " after frosts in June or early July. There is no legal " close season " but growers are urged to harvest the top crop and to cut and burn the stalks as early as possible so that ploughing may be done close to the winter rains, if cotton is to follow cotton.

A planting rain did not occur this season until the last week of October, when it was possible to plant 32 acres of experiments before the surface dried out. Sixteen acres of this planting were destroyed by the very severe hailstorm at mid-November. This area and the rest of the programme of 63 acres of cotton experiments were planted at mid-November following this storm—the bulk of the investigations thus being started late for obtaining satisfactory yields, judging from past seasons' results. The terrific pounding force of the combined hail and torrential rainfall, compacted the soil to plough depth and as a result penetration of storm rains was inefficient for the rest of the season—run-off being pronounced even on slight slopes, particularly on the sandy clay soils.

A relatively shallow-rooted type of plant resulted from the combination of compacted soil and inefficient rainfall, in all of the rain-grown experiments. Frequent rainfall was thus required to maintain satisfactory plant development and consequently the plants reacted quickly to some of the dry spells interspersed between the sharp heavy rains. Although good rainfall occurred during January, the lack of penetration of much of the rain into the hard surface soils resulted in most experiments requiring additional moisture early in February. But as only well below normal rainfall was received from then on, all crops were quickly forced to maturity and no top crop was produced. Under the dry conditions grades were higher than usual although the character of the bulk of the cotton was below normal.

The more important results obtained in the various experiments relating to cultural practices are as follows :—

Time of Ploughing Rhodes Grass.—The main investigation of the effect of time-of-ploughing Rhodes grass embraced ploughings in 1944 at the end of March, early in June, and early in August, with plantings superimposed on them at the end of October and on November 20th—in the form of a $3 \times 3 \times 2$ experiment following Rhodes grass of four years' establishment. Soil moisture determinations after the August ploughing indicated that the March ploughing of the Rhodes grass had conserved more subsoil moisture at 36 inches than the other two ploughings. It was obvious, however, that the Rhodes grass during the very dry weather in March, prior to the ploughing of that month, had greatly reduced the subsoil moisture in the first 2 feet of soil although approximately 8 inches of rain had occurred in the middle of February.

Unfortunately, the hailstorm reduced the stand in the October planting so seriously as to make the yields obtained non-representative.

In the November planting, the March-ploughed plots producing at the rate of 167 lb. raw cotton per acre tended to outyield the other ploughings.

An additional investigation of the effect of time-of-ploughing consisted of a 4×2 split plot experiment testing the effect on cotton yields of March and June ploughings after Sudan grass following maize, and after Rhodes grass of two, three and four years' establishment. Moisture determinations taken just after the June ploughing indicated once more that ploughing in March conserves subsoil moisture to a greater depth than is normally possible with June ploughing. This experiment was planted at the end of October, and, although the severe hailstorm damaged the stand, sufficient plants remained unfortunately to cause a decision to be made not to replant the experiment. The soil was badly packed around the young plants, however, and they made very slow and irregular growth ; the final stands following both Sudan grass and Rhodes grass of two years' establishment were outstandingly poorer than those following Rhodes grass of three and four years' establishment. The yields obtained indicated clearly that under the seasonal conditions experienced, cotton planted on the March-ploughed areas outyielded the June ploughing, and that Rhodes grass as a preceding crop was beneficial in the ascending order of 2, 3 and 4 years' age of establishment, Sudan grass being decidedly inferior to all except the two years of Rhodes grass.

A similar experiment to the one just reported, except that it consisted of Triumph and Miller planted on November 20th, produced the same order of yields for the soil treatments. As is usual for such late plantings, the quick-fruiting Triumph outyielded the slower-fruiting Miller, with the former well ahead on the first picking and the latter leading to a lesser degree in the second picking.

A test was conducted of the residual effect of the March and June time-of-ploughing Rhodes grass experiment reported in the last Progress Report. No significant differences were obtained, due, possibly, to the dry season tending to inhibit nitrification.

The results as a whole confirm previous findings that it is advisable to plough grassland soon after the occurrence of a deep penetrating rain in February rather than leave the grass as pasturage during either the late summer or autumn as is frequently commercially practised.

Cross-Harrowing Experiment.—The design of this experiment was similar to the one reported last season. The mean number of seedlings resulting from rates of sowing of 12, 18 and 24 lb. delinted seed per acre agreed closely with the data obtained in last season's experiment, being in 4½ feet-row spacings respectively, 2·76, 4·36 and 6·17 seedlings per row foot. The first cross-harrowing when the seedlings were 2–3 inches tall removed approximately 38 per cent. of the seedlings. The second cross-harrowing, done eight days later, removed roughly

24 per cent. of the remaining stand—the larger plants with a better developed rooting system withstanding the harrowing more than the smaller plants. The third cross-harrowing was done seven days later and removed a mean of 18·6% of the remaining stand, the final mean stands per row foot being respectively 1·17, 1·76 and 2·25 plants. The final counts of stands of plants in the plots hoe-thinned to single plants spaced approximately 12 inches apart, indicated clearly that there were significantly more spaces over 24 inches wide between plants in both the 2 and 3 cross-harrowed plots than in the control plots, particularly in the 12 lb. sowings. The results indicated that planting at the rate of 18 lb. delinted seed per acre provided sufficient seedlings to allow of three cross-harrowings being carried out without adversely affecting the final stand of plants. The three cross-harrowings not only markedly reduced weed growth in the rows of plants, compared with the non-harrowed plots, but also removed sufficient plants to make thinning by hoe unnecessary, as shown by the lack of significant differences between the yields obtained in the experiment. Plant growth was small under the seasonal conditions experienced so the results may not be indicative of the merits of the respective treatments in taller cotton. Further work is therefore required before this investigation can be finalized.

Stubble Mulch Experiment.—Several small areas which were under Giant Setaria, Sudan grass and wheat in 1943–44, were devoted to preliminary studies of the merits of planting cotton in a " stubble mulch." The method of seed bed preparation used was, after the fodder crop had been cut, to plough the stubble with a two-furrow mould board plough with the mould boards removed. The companionate controls were ploughed in the ordinary manner with a 2-furrow disc plough. Rains early in the winter promoted sufficient weed and grass growth to necessitate similar ploughings being repeated early in October. Very little stubble remained on the surface in the area previously under Giant Setaria but the Sudan grass provided sufficient stubble to bring about some improvement in yield. On the area following wheat cut for hay, a more extensive experiment was conducted which comprised ploughing with and without mould boards and also with a disc plough. This area was on sufficient slope to experience severe run-off in the mid-November storm, which washed much of the mulch off the surface. Without this mulch protection the sandy clay soil was so badly packed that poor penetration of rainfall was obtained for the rest of the season, thus making the investigation a complete failure.

A more extensive set of investigations will be conducted in the coming season, however, as it is possible planting in a " stubble mulch " may obtain better penetration of the rainfall, particularly the sharp beating type of storm rains.

Residual Rotational Trial.—An investigation testing the merits of growing cotton following cotton, grain sorghum and autumn-grown potatoes, was reported upon in the Progress Reports for 1942–43.

The same crops were grown in the 1943–44 season preparatory to repeating the experiment in 1944–45. Moisture determinations of samples taken prior to planting the cotton at the end of October, 1944, indicated that the soil was at virtually field capacity from 6 to 48 inches in the areas following potatoes. The previous sorghum plots contained fair moisture to 18 inches but there were only 12 inches of moist soil following cotton. Moisture determinations taken after planting, when the plots had received a total of 3·23 inches, indicated that the former potato plots were wet to 72 inches, while those after sorghum were wet to 24 inches and after cotton to only 18 inches. Determinations made prior to the first planting rain indicated that moderate amounts of nitrates were present in the surface 6 inches of this old cultivation with the plots following grain sorghum containing significantly less nitrates than the other two treatments.

During the long dry period in February and March, growth ceased in the plots following cotton and grain sorghum, but in the areas following potatoes no signs of severe stress were exhibited even at the first picking at the end of March. The yields in lb. raw cotton per acre obtained then were as follows :—following potatoes, 238 lb. ; following grain sorghum, 145 lb. ; and following cotton, 93 lb. No further yield was obtained following cotton, but a final picking of the plots after potatoes and grain sorghum increased the total yields of these two treatments to respectively 310 and 163 lb. raw cotton per acre.

The results clearly portray the value of having ample subsoil moisture to a good depth at planting time and confirm the findings of the 1942–43 experiment. In both experiments, however, the better yields following potatoes were produced under conditions of below normal rainfall at critical periods in the growth of the cotton crops. Such conditions prevented not only rank growth of plant but also tended to restrict nitrification, so that the very vegetative type of plant growth that usually occurs in a more normal season on old cultivations of fertile alluvial soils did not develop. Evidence was obtained in each experiment, however, that the plants following potatoes required only slightly more favourable growing conditions at mid-season to have developed into the rank vegetative type of growth that has resulted in other districts where cotton has followed potatoes in wetter seasons than occurred during the two experiments. The rotation appears of doubtful value, therefore, for rain-grown cotton on the fertile alluvial loams in which potatoes are normally grown. The results demonstrate clearly, however, the value of ample subsoil moisture to tide the rain-grown cotton crops over the dry periods that occur to some degree in every season.

Soil Structure Studies.

Preliminary investigations were conducted to test the applicability of the findings of Dr. W. S. Martin, of Uganda, relating to the effect on soil structure produced by growing grasses in rotation with

cotton crops[1]. It was found by using his suggested technique, except that only one sieve with 0·7 mm. apertures was used, that in a virgin grassland on a heavy clay alluvial loam, 49% of the soil aggregates would not pass through the 0·7 mm. sieve compared to 23% in an adjacent 19-year-old cultivation. In a heavier soil, with a moisture equivalent of 27–28%, a 20-year-old cultivation that had been repeatedly cropped mostly to cotton, had 34% of its aggregates larger than 0·7 mm. compared with 42% in an adjacent area of this soil type, which was at the end of the first season of cotton after three years of Rhodes grass.

In another series of samplings of the top 6 inches of this soil type it was found that the percentage of aggregates larger than 0·7 mm. was significantly greater at the end of the first cotton season after three years of Rhodes grass than at the end of the third cotton season after three years of Rhodes grass and was nearly significantly greater than old continuous cultivation in which there was a high degree of variability between the ten samples taken. In the second 6 inches there was a highly significant difference between the former treatment and the other two treatments, which were equal to each other. The differences between the two zones were highly significant in all treatments—the first year after three years of grassland having means of 35 and 62% for the two zones respectively.

Sievings were also made of a series of samples taken from the top 6 inches of soil in the 4×2 split plot experiment discussed under "Time of Ploughing Rhodes Grass" in this Report. It was found that at the end of the first season after ploughing the grasses the 4 years of Rhodes grass treatment had a significantly higher percentage of water stable aggregates larger than 0·7 mm. than the other treatments, between which there were no significant differences, although the size of aggregates after the third year of Rhodes grass was greater than in the other two treatments, which were equal.

The method was also used in the site of the rain-grown *versus* supplementary irrigation experiment, where previous determinations made with the Keen method of sieving dry soil through a nest of sieves had indicated at the end of a season that the surface soils in the spray-irrigated areas broke up into larger clods at ploughing than the accompanying rain-grown plots. No significant differences were obtained with the Martin method, however, in this five-year-old cultivation; this would appear to indicate that any tendency to increased cloddiness in the surface soil brought about by spray irrigation is only a temporary effect at the end of the season.

The results obtained with this method of testing soil structure confirm the conclusions drawn from voluminous soil moisture determinations in past seasons at the Experiment Station, namely, that new cultivations after either native grassland or Rhodes grass

[1] "Grass Covers in Their Relation to Soil Structure." W. S. Martin, Empire Journ. Expt. Agriculture, Vol. 12, No. 45, January, 1944.

are more permeable than old cultivations. Previous investigations have also demonstrated that three years' growth of Rhodes grass reduces nitrification to such an extent that a suitable balance of nutrients for the cotton plant usually exists in the first two seasons after the grass is ploughed out, if there is ample moisture available. The rate of nitrification increases during this period if cotton is grown, however, with the result that in fertile soils there is generally an excess of nitrates for cotton in the third season, unless very good rainfall is experienced by that crop—especially at early planting time. The soil structure studies appear to indicate that a decrease in the percentage of aggregates of a size of 0·7 mm. or larger occurs in the top 6 inches of soil during the first three years of cotton-growing after grassland. It would appear, therefore, that the phenomenon of rank growth of cotton which frequently occurs on old cultivations of fertile heavy clay loams and clays in Queensland is caused by an excess of nitrates in the top 12 inches of soil brought about by both a high rate of nitrification during the first half of the growth of the plants and an accumulation of nitrates resulting from the fact that the impaired soil structure prevents all but very prolonged rainfall from leaching the nitrates from this zone.

The results obtained in the soil structure studies and the residual rotational trial appear to confirm the soundness of the hypothesis that a rotation embracing (*a*) cotton following grassland ploughed close after the " wet season " to conserve all possible subsoil moisture for the cotton crop, (*b*) grain sorghum to restrict nitrification following the first cotton crop and also to allow of early autumn ploughing to conserve as much as possible of the late summer, autumn and winter rainfall, (*c*) one crop of cotton following the grain sorghum, and (*d*) three years of Rhodes grass after the second cotton crop prior to repeating the cycle, offers the best prospects of obtaining satisfactory yields of rain-grown cotton irrespective of seasonal conditions.

Irrigation Investigations.

The investigations into the merits of growing cotton with supplementary irrigation were greatly handicapped through the area allotted to this work having to be replanted after the hailstorm. The late-planted crops made a rank growth which required a different time-table of irrigation from that normally used for the October plantings. Actually the very dry conditions after January were beneficial, for had a wet February been experienced it is doubtful whether yields similar to those obtained in the experiments would have been realized.

Effects of Supplementary Irrigation.—This experiment was originally planted with the jassid-resistant Miller strain Lot 1. Owing to the late date of the replanting (December 5th) it was decided to use Umil 12, a partially jassid-resistant Miller × U.4 hybrid bred by Mr. Marriott, which is a very quick-fruiting type. The plants in both the irrigation and rain-grown areas grew quickly and early

developed a fairly leafy habit of growth. Nitrate determinations indicated that the rate of nitrification followed the usual pattern, reaching the peak for the season at the end of December, with the rain-grown plots consistently containing more nitrates than the irrigation plots, which received a 3-inch irrigation prior to the first planting on October 19th. Rather a vegetative type of growth continued during the good rainfall of January, with flowering commencing at the end of that month. Although plant height was comparable in both treatments at that stage, the lower nitrate content of the irrigation plots apparently hastened the transition from the vegetative to the fruiting phase as flowering was always heavier in these plots throughout the season. The rank type of plant growth in the non-irrigated plots wilted badly during the latter half of February, with a consequent loss of potential crop. The irrigated plots required watering then, and again at the end of February, with a further watering at the end of March, making a total of 7·9 inches after the 3-inch pre-planting watering. The yields of raw cotton obtained on a per acre basis were 420 lb. for the irrigation areas and 173 lb. for the non-irrigated areas—exceedingly good yields for such a late planting in the Callide Valley.

Irrigation Varietal Trial.—The original planting of this experiment comprised three Miller strains, including the jassid-resistant Lot 1, New Mexico Acala and Rowden 70. Owing to the lateness of the re-plant (November 24th) it was decided to test the merits of the very quick-fruiting Triumph Strain OS.39–4 and Umil 12 against Miller Lots 1 and 39, and Rowden 70. Although a somewhat sappy type of plant developed in all varieties during December and January, flowering commenced at the middle of the latter month and progressed satisfactorily until mid-February, with OS.39–4 producing twice as many flowers as the next leading variety and the two Miller strains being consistently last. A decided reduction in flower production occurred in the second half of February, OS.39–4 and Rowden 70 being the most affected. From then on until the end of March, when flower recording ceased, the two Miller strains consistently flowered more heavily than the three quick-fruiting types. This sudden drop in flowering was caused by water stress resulting from delayed irrigation late in January, when several days of cloudy weather prevented the plants from exhibiting indications of their water requirements. A sudden change from this condition to intensely hot, dry weather, quickly revealed the plants' needs for an increased supply of water, which was applied, but probably a week too late to promote a continuation of the high rate of flowering. The incident illustrates the difficulty of obtaining maximum results with irrigation in late-planted cotton under conditions where the possible occurrence of rain is a complicating factor in determining the irrigation time-table.

The yields obtained confirmed the advisability of using the quicker-fruiting varieties for late planting—all three varieties of this type significantly outyielding the two medium rate of fruiting Miller strains. The yields in lb. of raw cotton per acre were as follows :—

Rowden, 551 lb. ; Umil 12, 536 lb. ; Triumph OS.39–4, 523 lb. ; Miller Lot 39, 465 lb. ; Miller Lot 1, 464 lb.

The boll size and quality of the fibre of Triumph OS.39–4 indicated once more that the very quick-fruiting, medium-bolled strains are not suited to the climatic conditions of the Callide Valley, even when grown with supplementary irrigation. Over the years a series of varieties and strains of this type have been tested at the Experiment Station and all have reacted, in regard to boll size and character of fibre, to even slight stress conditions occurring when the plants were heavily laden. The results which have been obtained from the fairly quick-fruiting, medium large-bolled Rowden in the last few seasons, are therefore very encouraging and may indicate that at last a variety is available that can yield better than the standard Miller when planted late on the fertile soils normally suitable for that variety, and can also produce good cotton.

Four irrigations totalling 8 acre-inches of spray application were required after the re-plant—making a total of 11 acre-inches for the season.

Soil Moisture and Nitrification.

The better yields of cotton that have been obtained on the Experiment Station in seasons experiencing wet winters and springs and followed by good rainfall throughout the growing season, compared with the yields produced in seasons with dry conditions to planting time and then moderately good rainfall after that, have aroused speculation as to the true explanation of such results. Soil investigations have indicated that in the former seasons there has been a good supply of subsoil moisture but a small amount of nitrate nitrogen in the top foot of soil, as compared with a limited subsoil moisture and high amounts of nitrates in the latter.

The question has naturally arisen whether the wet winters and springs have restricted nitrification throughout the season or whether the good rainfall through the growing season, particularly in the early summer, has leached the nitrates from the surface zone.

An experiment was therefore conducted in the winter, spring and early summer of 1944, in an endeavour to obtain some information on the subject. The treatments included in a 6×4 randomized block layout on a 4-year-old fallow on fertile alluvium were : (*a*) ploughed land non-irrigation ; (*b*) ploughed land, 2-inch spray irrigated early in July ; (*c*) same as (*b*) plus fortnightly 1-inch applications, except when equivalent rainfall occurred, and (*d*), (*e*) and (*f*) respectively, the same as (*a*), (*b*) and (*c*), excepting that the land was unploughed. The fallow had been cultivated sufficiently in the 4 years, however, to maintain freedom from weeds. The late winter and spring received only two light rain groups and the winter was milder than usual.

The results obtained indicated that as long as the top 3 inches of soil remained moist to field capacity during the winter, there was little change in the nitrate content of this zone, which was approximately 10 parts per million. As the temperatures rose in September and the

surface 3 inches of soil dried out, there was a rapid increase in the nitrate content of this zone in treatments (*a*), (*b*), (*d*) and (*e*) until by mid-December mean readings of 35 to 40 p.p.m. were obtained in it. In the fortnightly irrigated (*c*) and (*f*) plots, however, the moisture content of this zone stayed at field capacity until late October, when the irrigations were discontinued. No increase occurred in the nitrate content of the top 3-inch zone of these latter plots until both the maximum and minimum soil temperatures rose in October. An irrigation then reduced their nitrate content to nearly their earlier readings. With the drying out of the surface 3 inches following cessation of irrigation, the nitrate content of this zone increased rapidly to readings similar to those obtained in the other treatments.

The results of the investigation appear to indicate that during a wet winter and spring, much less nitrification occurs than under normal conditions for these periods. In a dryish September and October, however, the rate of nitrification increases as the surface 3 inches of soil warms up and dries out. Frequent rainfall during this period will both restrict nitrification and also leach much of the nitrates formed to the lower levels. The resultant combination of ample subsoil moisture and relatively low nitrate content of the surface foot of soil provides very favourable conditions for the satisfactory growth of the early-planted crops that can be established in such seasons. Consequently the good crops that are developed are brought to maturity as a result of the ample subsoil moisture present during the rest of the season.

Cotton Varieties.

Several experiments testing the merits of a range of varieties and strains thereof were conducted in combination with various soil treatments. Very poor yields were produced as a whole by these late November plantings, so information of little value was obtained. There was a tendency, however, for Rowden 40–6–F.3 to outyield all other varieties in most of these rain-grown trials.

Cotton Breeding.—Good progress was made in several directions in the cotton breeding programme, both in regard to improving Miller and evolving jassid-resistant strains of this and other varieties. Further multiplication of the mass selection from Miller, mentioned in last season's Progress Reports, was achieved and a good foundation stock is now available to replace the main commercial strain of this variety. Very encouraging results were also realized in the main progeny block of Miller located on a farmer co-operator's property near the Experiment Station. Evidence was again obtained that in this material there is a high degree of correlation between the performance of parent plants and subsequent progenies, particularly in regard to lint percentages. The outstanding progeny increase of this group yielded 38·4% lint compared with a mean of approximately 35% for the main commercial stock of this variety.

The main jassid-resistant breeding programme was again handicapped by the absence of a severe attack by jassids. Accordingly the same measurements of merit practised last season had to be adopted again. The conditions provided an excellent opportunity, however, to test the respective merits otherwise of the more advanced strains of Miller and hybrids between Miller and U.4 developed for jassid-resistance. The results indicated that some very promising strains are now available. The highly-resistant Miller Strain III–26–0, which was released as Lot 1, performed well under dry conditions—yielding approximately 200 lb. raw cotton per acre. This strain will accordingly be the main jassid-resistant cotton for releasing in areas where this type of Miller cotton is required. Newer very promising jassid-resistant Miller strains are under investigation, however, which produce longer fibre and have a more open habit of growth and one of these may eventually replace Lot 1. Unfortunately the results obtained from Umil 12—the first Miller × U.4 hybrid released for commercial testing—indicated that while this strain is undoubtedly a very high-yielding quick-fruiting type, its lint percentage is substantially reduced by dry conditions. As re-selections with lint percentages up to 40 were obtained in the bulk stock of it, which only averaged 32% in commercial ginnings this season, further testing of this hybrid will be discontinued until a superior strain from one of the new selections is available.

Although work in the main hybrid progeny plot was handicapped by lack of a severe jassid attack, it was possible to assess the progress that is being made, by applying the hair density test. A rigorous programme of rogueing all plants with less than medium hair density was carried out and while some strains were entirely destroyed, a large number of strains had less than 10% of their plants removed, with 16 strains suffering no loss as every plant in them was densely hairy. As no severe jassid attack was experienced by the end of the season only strains with better than medium density of hairs were used for re-selection—in all a total of 70 strains being available with lint percentages ranging from 36 to 41, fibre length over $\frac{15}{16}$ of an inch and of satisfactory strength and bolls of good size.

In order to test a range of the more advanced material, advantage was taken of the fact that late-planted cotton grown luxuriantly by frequent supplementary irrigation, usually experiences sufficient attack by jassids to indicate its degree of resistance to this pest. The results indicated that many new strains of Miller and hybrids between Miller and U.4 selected for jassid-resistance were markedly resistant to the development of symptoms of jassid attack, and in this respect were much superior to present commercial varieties. However, while some of the hybrids yielded outstandingly in this experiment, the data relating to leaf hair, jassid reaction and yield figures, showed that many aspects of this problem remain unsolved. In conjunction with rain-grown plantings of this material, evidence was obtained which appeared to indicate that environment has a definite effect on hair character development.

ENTOMOLOGY.

During the 1944–45 season, weather conditions rather than insect pests determined crop yields. Some plantings in the experimental areas were destroyed in whole or in part by hail during the spring.

Heliothis activity after the commencement of flowering was characterised by three egg-laying peaks, the first in December, the second in early January and the third in early February. Larvæ developed in large numbers only after the early January peak and these caused a fair loss of squares. The failure of larval populations to develop after the other egg-laying peaks illustrates a common phenomenon which apparently has little to do with the age of the crop. Differences in larval populations on crops of different ages have been recorded, of course, but these differences occur when outbreaks are widespread.

Drought effects during mid-season brought out marked swale effects in the experimental areas and plot to plot records indicated that, under such conditions, the period of egg-laying may be prolonged in the swales where the plants are growing more vigorously than on the ridges. Selective oviposition was thus more pronounced than usual.

A time-of-planting experiment yielded negative results owing to hail and drought effects which were so severe in parts of the area that picking was not attempted.

The age-of-cultivation experiment confirmed earlier conclusions which showed that egg-laying is much the same on new and old land crops, though the subsequent larval populations are usually greater on the more vigorous crops growing on old cultivations.

Insecticidal experiments were designed to ascertain the influence of lead arsenate dusts and lead arsenate-molasses sprays on the pest when they are applied shortly after the recorded peak of egg-laying. Increased yields were obtained and these can be correlated with the reduction in larval populations brought about by each treatment. Some larvæ survive treatment, however, and there is evidence that better results may be obtained by applying the insecticide at short intervals after the rise in egg counts to a peak is first detected. In short, the machinery for an accurate spray or dust timing service can be provided with comparative ease; the control obtained with insecticides in attacks of varying intensities has still to be accurately measured.

EXPERIMENTAL PROGRAMME FOR THE SEASON 1945-46.

The proposed programme for 1945–46 embraces the following investigations.

Plant Breeding.—

(*a*) A continuation of the testing of the merits of the various generations of backcrosses of Miller and U.4.

(*b*) Increasing the multiplication of III–26 Miller or Lot 1 as it is known commercially, improving the uniformity of the Miller selections for jassid-resistance and plant and fibre characters, and testing the relative yielding ability and quality of fibre of the most advanced jassid-resistant strains of Miller.

(*c*) Studying the inheritance of hybrids of Ferguson with the New Mexico Acala, Lone Star and Triumph cottons.

(*d*) Improving the uniformity of the Miller 41S and New Mexico Acala strains now grown commercially.

Agronomic and Varietal Experiments.—A continuation of the general programme reported upon for the 1944–45 season with modifications in the experiments relating to both irrigated and non-irrigated cotton, to embody features arising out of this past season's work.

Entomology.—

(*a*) Age-of-land experiment to define further the effects of cropping history on the incidence of *Heliothis*.

(*b*) Time-of-planting experiment to measure egg-laying preferences of the insect on crops of different ages.

(*c*) Insecticidal trials on both irrigated and non-irrigated cotton to determine the relative efficiencies of lead arsenate, dichloro-diphenyl-trichloroethane, and hexachlorobenzene for the control of *Heliothis*.

SOUTH AFRICA

COTTON EXPERIMENT STATION, BARBERTON.

PROGRESS REPORT FOR THE SEASON 1944-45

BY

D. MacDONALD, W. L. FIELDING, D. F. RUSTON AND H. E. KING.

PART I.

STAFF.

The staff was increased during the season by the return from Military Service of Mr. W. L. Fielding in February and Dr. G. M. Wickens in July. At the end of the season, Mr. M. F. Rose was transferred to the Sudan, while Mr. D. F. Ruston has left for England to take up the post of Assistant Secretary in the London Office of the Corporation.

INTRODUCTION.

The past season was one of the most difficult on record since work at the present Station began, on account of the low and badly distributed rainfall, coupled with uniformly high mean maximum temperatures during the growing season.

A tabular summary of the season's conditions is given below in Table I.

TABLE I.

Planting Dates.	*Picking Dates.*	*Legal Close Season.*	*Rainfall.*	*Mean Temperatures.*
20th October 30th November 26th December	April–May End of May to Mid-July	NIL	Total for 12 months ending 30th June, 1945, 18·93 inches (Badly distributed).	1/10/44–31/3/45 Max. 85·1°F. Min. 63·3°F.

The main breeding work was again confined to Variety Tests of, and selection within, hybrid material bred in previous seasons. Details of the object of this work and the material used have been given by Mr. F. R. Parnell in his Introductory Note for the Season 1943–44.

Investigation into the relationship between hairiness and jassid-resistance was continued in *hirsutum*, *barbadense*, and *hirsutum* × *barbadense* material. The jassid population during the season was very high and enabled satisfactory progress to be made in this line of work, as well as in the breeding blocks, where jassid-susceptible types could be discarded.

An attack by Sudan bollworm (*Diparopsis castanea* Hamps.) on October-planted cotton damaged the early bolls, otherwise insect damage was negligible. Stainers were numerous from quite early in the season, but, for the third consecutive year, the incidence of internal boll disease was very low.

METEOROLOGY.

The total rainfall for the 12 months ending June, 1945, amounted to 18·93 inches compared with the mean of 28·14 inches for the twenty-one years since this Station began. Only in 1926–27 has a lower total been recorded, but in that year the distribution was rather better. Advantage was taken of the good rains of the previous season to get all ploughing finished during the early winter months. Following two good rains amounting to 2·85 inches in mid-October, no effective rain fell until the end of November, when a few light showers were recorded. December was extremely hot, temperatures up to 106°F. being recorded, while the rains did not break until the end of the month. During January and February moisture conditions were never good and it was not until March, when 4·50 inches were recorded, that a sub-soil moisture reserve was established. During the whole season on only eleven occasions were falls amounting to over half-an-inch recorded.

GENETICS AND BREEDING.

Main Variety Trial.—A balanced incomplete block trial of 25 strains by 12 repetitions was carried out to compare the yields of the 19 best U.4×Cambodia strains, as judged on previous seasons' results, with two U.4×M.U.8 and the four best U.4 strains, including 5143, the strain in general cultivation in this area.

The trial was planted on October 20th, when moisture conditions were adequate, but from mid-November until March moisture conditions were never sufficiently good to promote proper growth and development. During December, two small hand waterings, amounting to rather less than 1 gallon per plant, were given and while this prevented the plants from dying, it was not sufficient to stimulate growth.

Fair growth and good fruiting took place during the light rains of January and February and, although no effective rain fell between February 3rd and March 6th, the heavy March rains were just in time to save the crop, already set, from shedding.

The mean yield from all strains of 372 lb. lint per acre reflects the high drought-resisting character and general toughness of the strains under most adverse conditions. Individual yields, in lb. lint per acre, ranged from 441 to 274, with a difference of 34 required for significance at P=·05.

For the second successive year and under completely different climatic conditions, the best Cambodia crosses far outyielded the four U.4 strains. Of the 19 in the trial, 13 of them were significantly better than the best U.4 strain, while 16 of them and the two M.U.8 crosses gave significantly higher yields than 5143.

It is of interest to note that of the six highest-yielding strains in the 1943–44 trial, carried out under good conditions, five gave the highest yields in the present season's trial when conditions were very

bad. Of further interest is the fact that, as in the previous season, sister strains of the same family tended to give similar results.

The Cambodia × U.4 strain, A.2106, has for the second successive year, under widely different conditions, given the highest yield in the variety trials, far outyielding 5143, as well as being considerably more jassid-resistant, while its lint is in no way inferior. Accordingly, seed of this strain has been issued to selected farmers for multiplication during the coming season with a view to replacing U.4/5143, the strain at present in general cultivation.

The main results of the trial are embodied in the mean figures given in Table II.

TABLE II.

	Yield of Lint, lb. per acre.	*Ginning %*	*Seed Weight.*	*Lint Length, mm.*	*Lint Index.*
Mean of four U.4 Strains	318	38·9	8·8	29·6	5·6
„ „ nineteen 5143 × Camb. Strains ...	384	38·1	10·9	31·0	6·7
„ „ six best 5143 × Camb. Strains ...	423	39·0	11·0	30·9	7·0

M.U.8 × U.4/8161 Trial.—A further trial of 15 strains by 12 repetitions was carried out, comparing the yields of eleven M.U.8 × 8161 strains with the four U.4 strains included in the Main Variety Trial.

This trial was planted on the same date and on land adjacent to the Main Variety Trial, thus experiencing similar conditions throughout the season. The land under this trial, judged on past experience, was of rather lower fertility than that under the Main Trial and some of the strains suffered from premature leaf-fall due to *Alternaria*.

Yields in general, ranging from 390 to 224 lb. lint per acre, with a difference of 31 required for significance at P=·05, were lower than in the Main Trial, probably due in part to poorer soil fertility. Seven of the M.U.8 × 8161 strains significantly outyielded the best U.4 strain. The M.U.8 × 8161 strains, in addition to being better yielders than the best U.4 strains, all exhibit a considerably greater degree of jassid-resistance, while their lint, so far as it can be judged in the field and laboratory, is at least equal to that of the best U.4.

To illustrate the general results of the trial, mean figures are given in Table III for the U.4 strains and M.U.8 crosses separately, also for the best three of these crosses.

TABLE III.

	Yield of Lint, lb. per acre.	*Ginning %*	*Seed Weight.*	*Lint Length, mm.*	*Lint Index.*
Mean of four U.4 Strains	285	37·4	8·9	29·4	5·3
„ „ eleven M.U.8 × 8161 Strains ...	337	35·8	10·4	30·1	5·8
„ „ three best M.U.8 × 8161 Strains...	378	36·3	11·2	30·1	6·4

Early in March marked differences in the onset of senescence of leaves were noticed between strains in this trial. When such senescence occurs here it is usually associated with *Alternaria* infection. A detailed record was therefore made on March 12th, using a

classification of eight visual grades, ranging from Nil to Heavy senescence. The grades were subsequently allotted numerical values, 1 to 8; the frequency distribution shown by the figures over the whole experiment was approximately normal in form. Analysis of variance revealed highly significant differences between strains. The M.U.8×U.4/8161 lots, as a whole, were significantly superior to the control U.4 derivatives in retention of healthy, green leaf, at this stage of growth. A 332, the M.U.8×8161 derivative which gave the highest total yield, gained the highest mark (*i.e.*, the lowest grade for senescence) for healthy leaf, whilst U.4/5143, with 28% less final yield, showed the greatest degree of senescence. Differences in degree of senescence are often associated with differences in earliness, but these two strains both produced the same proportion of their total crop in the first two pickings.

Analysis of co-variance of senescence grade with total yield revealed a significant negative correlation both between *and within* strains. Between senescence grade and first-picking weights there was, however, a positive correlation.

It is impossible to deduce from these facts which is cause and which effect, though it is reasonable to suppose that retention of healthy leaf contributes towards higher yield in the later pickings.

In the above two trials certain points of statistical interest emerged from analysis of the figures.

The design of the Main Variety Trial was such as to permit a straight analysis on the basis of 25 strains × 12 random blocks or, alternatively, on the basis of 60 balanced incomplete blocks of 5 strains each. Analysis by the latter method, with a reduction in block size from 25 plots to 5 gave a gain in information of 125%. In order to obtain this amount of information with a straight random block experiment, it would have been necessary to have 27 blocks of 25 plots, requiring 125% larger area. The Main Trial, therefore, represents a case in which the balanced incomplete block technique was extremely advantageous.

With the M.U.8 Variety Trial the advantage was less marked. The data could be analysed as a randomized block experiment with 12 blocks of 15 plots or, utilising seven only of these blocks, as a balanced incomplete block design with 35 blocks of 3 plots. A comparison of the two methods, using only the seven replicates in each case, revealed a gain in information of only 18% for a reduction in block size from 15 to 3 plots.

Hybridization.

U.4/5143×Cambodia.—This material, consisting of 19 strains in F_6, was carried forward from the previous season as large selfed bulks in quarter-acre plots, as well as being included in the early-planted variety trial above. The multiplication plots, although planted on November 30th, only germinated when rain fell in the last week of

December. Despite the short growing season, they fruited remarkably well and exhibited a pleasing degree of earliness—a character essential to the success of any strain under our conditions.

Spinning test reports on lint samples of twelve of these strains from the 1943–44 crop, forwarded to the British Cotton Industry Research Association, show that broadly speaking their spinning quality is about the same as that of the U.4 strains included in the test. This is rather disappointing as the lint of these crosses, judged by measurements on combed seeds, has been consistently longer than U.4 lint over a number of widely differing seasons. However, the report states that " None of the measured hair characters shows any consistent relation with yarn strength and with one exception all spun considerably weaker yarns than would have been expected from the hair test results." The samples on which this spinning test report is based were grown in a season when conditions were very good ; a further set of samples grown under the very difficult conditions experienced this season, have been forwarded for spinning test.

The five 5143×Cambodia strains, mentioned in last season's report as having been crossed with selected Uganda B.P.52 plants, in an attempt to improve lint quality, were grown on quarter-acre plots. Special bulks made up of plants showing good fruiting and high jassid-resistance, coupled with as good lint as could be found under the drought conditions prevailing, are being carried forward.

U.4/8161×M.U.8.—Sixty-five single plants and twenty-seven special bulks of this material were grown on a five-acre block. The material as a whole was uniformly good for hairs, while fruiting, although more variable, was mainly good, considering the crosses were planted on December 26th and had only a short period, with erratic rainfall, in which to produce a crop. Long-linted types are less easy to find in this material than in the U.4×Cambodia lots and the difficult season tended to mask the differences that do exist in this character.

So far the reports on the spinning quality of these have only been obtained for two families in this group, one of which, both in appearance and strength of yarn, was equal to the best U.4 spinning type we have. A pleasing feature of one of the strains tested was that it gave an excellent combination of high maturity and, for our types, a very low hair weight.

Lint samples for spinning test of seven of the best yielding strains of this cross, along with the two U.4 strains taken from the M.U.8×8161 variety trial, as well as the M.U.8 parent, have been forwarded to obtain a general comparison.

Quality Crosses.—The main objects of this series of crosses have been given in the 1942–43 Report. The material consists of F_3's of (*a*) crosses made using U.4/5143 and M.U.8, hairy parents with good field character, and B.P.52, Tidewater, Gen.33 and Meade, all types carrying good quality lint ; (*b*) backcrosses of the above Meade

and B.P.52 crosses to selected hairy plants of B.P.52, in an attempt to improve lint quality without a corresponding loss of hairiness.

M.U.8×Tidewater.—A special bulk of this cross, together with progeny plots of five single plants selected the previous season was grown in a half-acre plot. While much variation was exhibited by the special bulk plot, a fair proportion of plants giving a good combination of hairs, fruiting and fine lint could be found. Of the five progeny plots only one was inferior to the bulk, while two of them were markedly superior, showing a high degree of uniformity, a large proportion of the plants combining good early-fruiting and leaf hairs only a little inferior to M.U.8, coupled with lint approaching that of Tidewater in length and fineness. The strength of the lint in the above cross was, on the whole, rather weak, and it remains to be seen whether this is an inherent character, or whether it is mainly due to very heavy fruiting under extremely adverse conditions preventing normal development of lint hairs. Forty-one single plants and five special bulks are being carried forward for the coming season.

M.U.8×Meade.—This group, consisting of one special bulk and six single plants, did not possess the same high level of good hairs, fruiting and lint as M.U.8×Tidewater, and plants combining these characters were much more difficult to find. The general level of lint length was much below that of Meade, and while long-linted types could be found, this character was commonly associated with low ginning and poor fruiting.

U.4/5143×Meade.—In this cross, the average lint length was rather better than in the similar M.U.8 cross, but long lint was again associated with low ginning, although not markedly so with poor fruiting. On the other hand it was difficult to find plants as hairy as U.4, with lint approaching that of Meade in length and fineness.

M.U.8×Gen.33 and U.4/5143×Gen.33.—Both these crosses were similar in that they showed a fair degree of uniformly good fruiting, with hairs approaching that of the hairy parent. The lint, however, was more variable, and while the mean length of the selected plants was about the same in both crosses, the ginning percentage of the 5143 cross was definitely higher.

U.4/5143×B.P.52 and M.U.8×B.P.52.—Neither of these crosses showed a high degree of uniformity in either plant habit or fruiting and, while the standard of hairs was better in the M.U.8 cross, the lint of the 5143 cross was distinctly longer and ginning percentage higher.

Backcrosses.—F_1's of the above two crosses had previously been backcrossed to selected hairy plants of B.P.52 in the hope of improving lint quality without loss of hairs. In the M.U.8×B.P.52 backcross plot, many plants possessed better lint than the straight cross, but it was less easy to find plants showing this improvement without a corresponding loss in hairiness. In the similar 5143×B.P.52 backcross, little difference in lint quality or hairiness, compared with the straight cross, could be found.

M.U.8×Meade and 5143×Meade had also been backcrossed with selected B.P.52 plants. Here, again, the M.U.8×Meade backcross showed an improvement in lint quality over the straight cross, while backcrossing had little effect on the 5143×Meade cross.

U.4/8161×Sea Island and Egyptian.—509 single-plant selections, the F_5 from these two crosses, were grown on a 16-acre block. Of this total 440 were selections from the Sea Island cross.

These crosses were planted on November 30th, after light showers, but lack of a following rain made germination uneven, the bulk of the seed only germinating after the rains in the last week of December. Uneven and mainly late germination made selection work very difficult, but an advantage of the short growing season was that it showed up early types. In last season's report it was mentioned that there was a tendency for early-maturing types to be associated with shorter and harsher lint than the standard aimed at, and it remained to be seen whether this tendency could be broken effectively. It is still too early to state categorically that this tendency can be broken, but records during the season showed that a high degree of uniformity for good early-fruiting in conjunction with lint of the desired quality, as judged by length and feel, was present in several families.

While many progenies still remain very mixed for many characters, both the percentage of progenies showing this marked variation, as well as the number of useless plants within progenies, were considerably less than in the previous season. It was thought that the high standard of fruiting of many good lots in season 1943–44 was partly due to good seasonal conditions and hybrid vigour. This season, many of the progenies of these good lots, though growing under very adverse conditions and with a presumed diminution of hybrid vigour, again proved to be prolific fruiters.

The general standard of leaf hairs in the crosses is far superior to the best U.4 and many of the hairiest lots breed reasonably true for good hairs and good fruiting. This is particularly so in the case of progenies derived from parent plants possessing good stem hairs as well as good leaf lamina hairs, but progenies from plants with good leaf hairs and naked stems, showed a marked splitting for hairs, fruiting and lint.

A total of 603 single-plant selections, of which 490 are from the Sea Island group, together with 13 special bulks, are being carried forward for planting next season.

U.4/5143×Egyptian.—Twenty F_3 progenies were examined to see how they compared with the U.4/8161×Egyptian progenies. 5143 is a rather more jassid-resistant and better fruiting type than 8161, but its lint is slightly shorter and harsher. The cross was made to see if it was in any way superior to 8161×Egyptian and as its behaviour during the past two seasons in no way indicates that it is, only very few selections are being carried forward.

M.U.8 × Sea Island.—A two-acre block of this material was grown, comprising 73 single-plant selections from F_2. Broadly speaking, a similar variation was found in hairiness, lint and general field characters to that of the U.4 × Sea Island cross when in the F_3 stage. The main differences were that the upper levels of leaf hairiness, especially in length of hairs, were rather better than in the similar U.4 cross, while the lint lengths were rather shorter. A total of 110 single-plant selections is being carried forward, consisting of 75 economic types and 35 plants giving the best length-density combination of leaf hairs that could be found in the material, irrespective of other characters. These hairy plants will be used both for straight selection and as parents for hybridization work in order to produce extremely hairy types for trial in connection with resistance to *Lygus*.

Sea Island, Egyptian and Tanguis × B.P.52.—F_2 bulks of each of the above crosses were planted in quarter-acre plots on December 26th. Though plant growth and fruiting were mainly good, the season was too short to enable the full crop to mature. Accordingly no individual plant selections were taken, the material being carried forward in the form of large special bulks made up of selected plants showing a combination of good hairs and lint with reasonable field characters.

Hairiness and Jassid-Resistance.

Studies of hairiness and jassid-resistance, described in last season's report, have been continued on a considerable scale. Confirmation of the conclusions arrived at last year has been obtained, and much additional information recorded, although the data have not yet been fully analysed. It is intended that the results, when complete, shall be included with a full account of the work on this subject, to be submitted for publication. Some only of the new points emerging are given briefly below.

Degree of Jassid-Resistance Attainable by Breeding for Hairy Leaves.

A small experiment in which very late sown plants were exposed to extremely heavy infestation by jassid, gave evidence that hairiness approximating to the standard of M.U.8 conferred almost complete protection, once the seedling stage was passed. The first few leaves were heavily infested and damaged, but beyond the 7th leaf up the main stem, nymphs averaged less than 0·2 per leaf, while on neighbouring non-hairy plants the *whole* of the foliage was so heavily infested that the plants were virtually destroyed. This protection was equally definite whether the plants were in fact M.U.8 or were selections of U.4 × Sea Island origin approximating to M.U.8 in degree of leaf hairiness. It should be noted that the best plants of hybrid origin in the breeding work described earlier show a substantial advance over M.U.8 in hairiness. All such plants remained entirely free from jassid damage throughout this season of very heavy infestation on susceptible cotton.

The Development of Hairiness with the Growth of the Plant.

As previously recorded, the earliest-formed leaves on even the most hairy strains are virtually non-hairy, and the degree of hairiness increases progressively from node to node with the growth of the main stem. It would appear from this season's results that the point at which full hairiness is attained is not only markedly variable from type to type, but is also liable to be modified by growing conditions. Typical results of hair counts on the lower surface of the lamina are illustrated in Fig. 1. The points on the graphs represent counts of hairs per sq. cm. reaching a height of 0·3 and 0·5 mm. from the lamina surface, taking the first true leaf (giving a count of 0 in all cases) and then every third leaf from the *sixth* upwards. In order to facilitate the comparison of leaves formed at approximately the same *time*, on types having different growth rates, the horizontal scale gives the approximate time of formation of the leaf, and not the node number.

Four points of importance are evident from these graphs :—

(1) There is a marked tendency to a drop in hairiness on leaves formed about 70 days from planting, with later-formed leaves showing a recovery. This is believed to be the result of a period of drought terminated by rain on the 74th day.

(2) The *G. barbadense* strain, X1730, shows this effect to a much smaller extent than the *G. hirsutum* types. At least a partial explanation of this may lie in the almost complete absence of bolls on the X1730 at this date in contrast to the earlier and heavier fruiting *hirsutum* strains.

(3) The pre-eminence of M.U.8 in " hairiness " is most strikingly brought out by the counts of hairs at a height of 0·5 mm., although at 0·3 mm. it is little better than X1730 in the maximum count recorded.

(4) The rate of attainment of hairiness of these two strains differs very greatly, even when allowance is made for the rather more rapid node production of X1730. This latter strain only attains at Node 24 the level reached by M.U.8 at Node 12 some *forty days* earlier.

Differences in rate of attainment of hairiness, as well as in its final degree, must, of course, be considered in studies of jassid-resistance and in breeding hairy types. It is probable that differences in this respect exist within the species *G. hirsutum* as well as in hybrids between *G. hirsutum* and *G. barbadense*.

The development of hairs on the midrib shows a similar increase up the main stem, and a similar apparent susceptibility to abnormal growth conditions. It is of interest to note also that successive leaves formed on fresh growth of ratooned plants show a gradual development of hairiness comparable to that of seedling cotton.

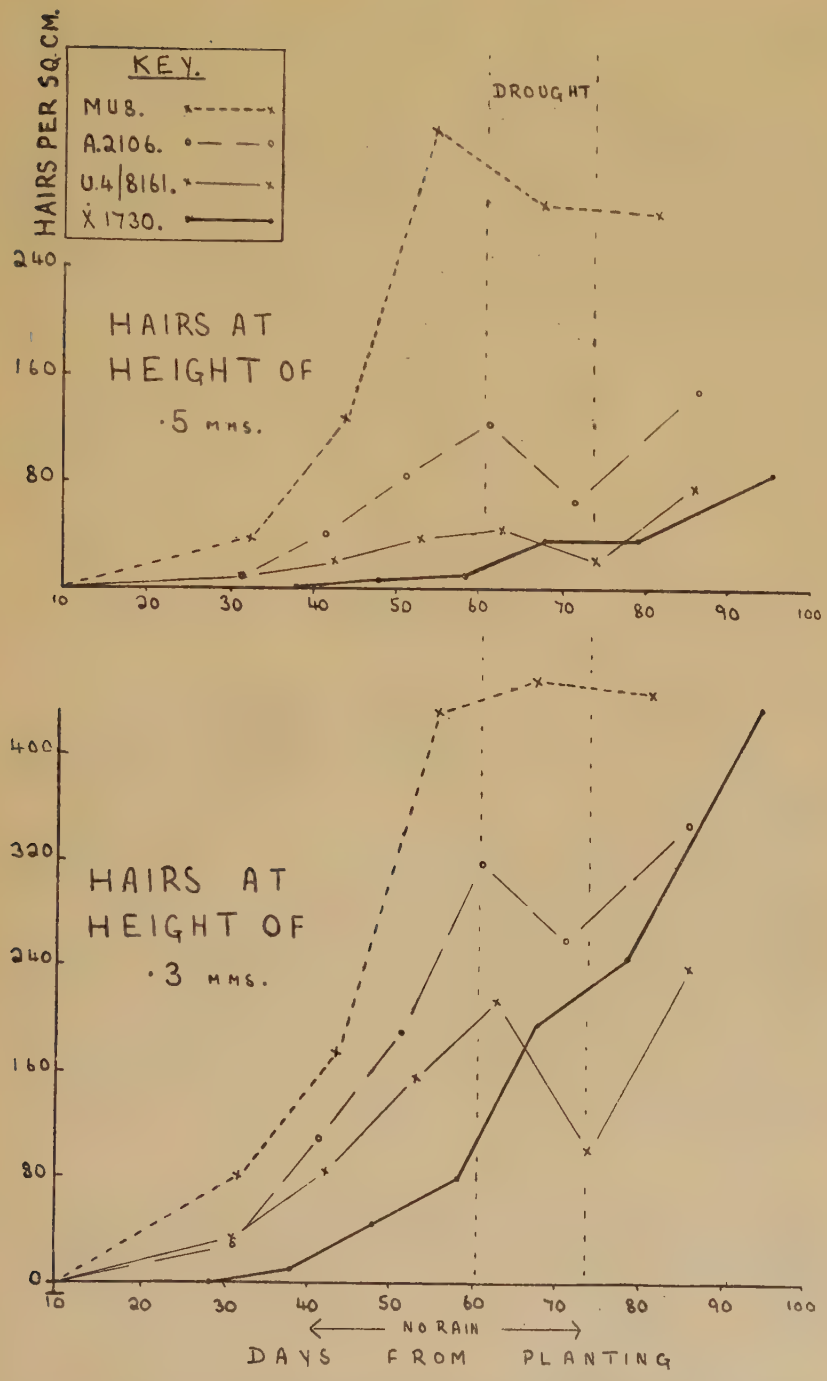

FIG. 1.—HAIRINESS OF LAMINA OF MAIN STEM LEAVES PRODUCED AT INTERVALS THROUGH THE SEASON.

The Development of Jassid-Resistance with the Growth of the Plant.

The importance of studying the development of hairiness on the young plant is brought out by the results of jassid counts presented in Table IV. The comparison is between two strains differing very markedly in the final degree of hairiness attained. In the earliest stages of growth (*i.e.*, up to the third true leaf) hairiness does not differ, and the counts of jassid nymphs indicate no difference in susceptibility. From this point onwards the progressively increasing difference in hairiness between the two strains is strikingly reflected in the very rapid divergence shown by the jassid counts.

TABLE IV.

The Relationship between Jassid Counts and Lamina Hairiness on Successive Leaves on the Young Plant.

Main Stem Node Nos. from bottom.	*Hairs per sq. cm. of lower surface at height of 0·5 mm.*		*Jassid Nymphs per 100 leaves.*	
	M.U.8.	*Meade.*	*M.U.8.*	*Meade.*
	Planted 24th November, 1944—			
14–16	459	62	0	675
11–13	215	21	1	535
8–10	194	15	7	249
5– 7	47	4	24	188
	Planted 18th December, 1944—			
11–13	259	71	3	529
8–10	192	31	10	944
5– 7	30	2	59	663
4	(16)	(0)	71	331
3	(0)	(0)	107	117

Hair counts are based on lamina strips taken from the central leaf of the three.

For nodes 4 and 3, the hair figures are only approximate, being typical counts for similar leaves in other experiments.

Germination and satisfactory early growth were obtained with these two planting dates by resort to repeated hand-watering.

From this Table it will also be seen that, node for node, the later planting carried, in general, a higher infestation, reflecting an increase in population through the season. The earlier-planted cotton showed a lead of three to four nodes in growth over the later. To make a comparison, therefore, of leaves of similar age, exposed to infestation over the same period of time, it is necessary to compare, for example, nodes 8 to 10 of the earlier planting with nodes 5 to 7 of the later. When this comparison is made it is seen that the leaves on the later planting carried more nymphs than leaves on the earlier planting *formed at the same time, but produced higher up the stem*, and therefore more hairy.

This result was also obtained in other experiments this season, and in a preliminary investigation reported last year, indicating that the increased susceptibility of late-sown cotton is a result of lack of hairs in the early stages of growth.

The Relative Importance of Hairs on Leaf Lamina and Midrib.

Hairiness of lamina (lower surface) and of midrib, are, in general, related, and hence any measurement of one is in effect a measure of the other. In normal material, therefore, it is not possible to obtain

any convincing evidence as to which of the two has the primary influence on jassid-resistance, or whether in fact both are separately of direct importance.

A study has, therefore, been made on hybrid material in which the normal degree of relationship has been markedly reduced by deliberate selection. By this means it has been possible to obtain a proportion of plants showing moderately good midrib hairiness with very poor lamina hairiness and *vice versa*. Table V gives data from this material and suggests at once that while the highest jassid-resistance is obtained when *both* lamina *and* midrib hairs are "good," the possession of a good degree of hairiness on *either one or the other* is sufficient to confer a very definite degree of resistance.

The term "good" is used in a relative sense only, the best class in the Table representing about the standard of U.4/5143.

TABLE V.

JASSID INFESTATION ON GROUPS OF PLANTS DIFFERING IN HAIRINESS OF LAMINA AND MIDRIB.

	Lamina Bad.	*Lamina Good.*
Midrib Bad	*25 Plants* Jassid 254 Lamina Hairs 33 Midrib Hairs 26	*16 Plants* Jassid 105 Lamina Hairs 80 Midrib Hairs 27
Midrib Good	*16 Plants* Jassid 86 Lamina Hairs 39 Midrib Hairs 85	*26 Plants* Jassid 59 Lamina Hairs 83 Midrib Hairs 91

The figure given for jassid infestation is the *geometric* mean of counts of nymphs on three leaves of each plant, expressed as nymphs per 100 leaves.

The figure for lamina hairs is the mean number of hairs, per 100 sq. mm. of lamina surface, reaching a height of 0·5 mm.

The figure for midrib hairs is the mean number, per 20 sq. mm. of midrib surface, reaching a radial distance of 0·6 mm. from the surface.

Confirmation that lack of hairs on the lower surface of the midrib does not necessarily result in susceptibility, provided the lamina is hairy, has been obtained from other material. A selection of *G. barbadense* origin (Woolly N.T.2), has been found to possess a high degree of resistance. This is associated with very good lamina hairiness, extending right up to the sides of the midrib, but the exposed lower surface of the midrib is virtually non-hairy.

SHEDDING OF HAIRS.

In view of the possibility that cotton leaf hairs are deciduous, an experiment was carried out on U.4 cotton to determine whether appreciable shedding of hairs took place during a period of six weeks subsequent to the leaf attaining full size. No evidence was found to suggest that hairs are shed from either lamina or midrib, nor was there any observable change in the height of the hairs. It may be pointed out in this connection that, so long as a growing leaf continues to increase in size, a proportionate reduction in hairs per unit area is observable, but that this is not evidence of "shedding." With

G. hirsutum cotton, at Barberton, the leaf does not normally reach full size until approximately one month after first commencing to unfold.

Experiments.

Premature Leaf-fall.—The background of this problem was outlined in the 1940–41 Report, page 25. In a manurial experiment, described in the 1941–42 Report, page 28, it was found that compost improved growth and delayed leaf-fall, whilst potash produced an equal delay but only slight increase in growth. Both compost and potash increased yield. A minor element experiment described in the 1943–44 Report, page 30, showed that boron, copper, zinc, magnesium and manganese had no effect on growth, yield or *Alternaria* infection, but that potash, which was used alone and in combination with minor elements, increased growth and delayed premature leaf-fall sufficiently to double the yield of lint per acre.

Following up these previous indications, an experiment was carried out this season to investigate the effect of different levels of potash supply, at various times of application.

Nine treatments were given, using a randomised block layout with six repetitions :—

K 100 ; K 100+K 100 ; K 200 ; K 200+K 200 ; K 400 ; Nil ; Nil+K 100 ; C ; C+K 200.

C=10 tons per acre compost from kraaled wastes, ploughed in (equal to approx. 125 lb. K_2O and 104 lb. Total N).
K 100=100 lb. KCl per acre ploughed in.
+K 100=100 lb. KCl per acre applied as top dressing at time of full flowering.
In the treatment C+K 200, however, the KCl was ploughed in.

The experiment was planted with U.4/5143 cotton on October 20th. Following the application of the potash top-dressing on January 24th, some very light showers fell towards the end of the month, and a fall of over 2 inches was recorded on the first two days of February. It had been intended to apply a treatment of a further top-dressing as soon as the Nil plots showed signs of going off, but the rapid general spread of *Alternaria*, coincident with heavy March rains, made this not worth while.

Green weights of plants at 45 and 84 days from planting showed all treatments to be significantly more advanced in growth than the Nil plots, on both occasions, except K 100, which showed a suggestive effect only at 45 days. C+K 200 and C gave the highest weights.

Commencing on February 15th a series of weekly counts was made to record *Alternaria* infection ; these records embraced all treatments and blocks, making statistical analysis possible. Early infection was too light to make the results of real value, but, after a heavy rain in early March, marked differences were observed and the figures are recorded in Table VI.

TABLE VI.

Treatment.	Percentage of plants showing Medium to Heavy Infection on three dates in March, 1945.		
	March 9th.	*March 15th.*	*March 22nd.*
C+K 200	4·68	21·72	37·40
C	12·15	26·10	35·48
K 400	1·28	12·00	26·22
K 200+K 200	9·97	26·97	37·63
K 200	7·40	26·65	39·45
K 100+K 100	16·15	31·92	43·88
K 100	11·60	33·60	45·32
Nil+K 100	18·70	36·12	48·32
Nil	19·93	40·83	49·60
P=·05	6·89	12·66	15·74

Table VI illustrates the rapid increase in infection which, as mentioned above, became general in early March. It also illustrates the delaying action of some of the manurial treatments, particularly, of K 400, but shows that under the conditions experienced this season the application of an additional K 100 as a top-dressing had no beneficial effect on the healthiness of the leaf.

Final yield figures were on the low side, but revealed highly significant differences. C+K 200 gave a significantly higher yield than all other treatments at P=·01, whilst all treatments were significantly better than Nil and Nil+K 100, at P=·01.

Thus, under considerably different meteorological conditions from those to which previous experiments were subjected, the general result has been the same. Compost has had a greater effect on early growth of the cotton plant than has potash, whilst potash has delayed leaf-fall, normally associated with the spread of *Alternaria* infection, sufficiently to have a marked beneficial effect on final yield. Under this season's conditions the application of a top-dressing of K 100 or K 200 to Nil plots and to plots in which K 100 and K 200 had been ploughed in, gave no increase in yield.

Fineness-Maturity Relationship in Cotton Lint.—Two sets of samples were sent to the Shirley Institute in connection with an investigation on this subject.

The first set of samples was a fully randomized collection from a field of U.4/5143 specially set aside for the purpose in 1943–44. Bolls were taken at intervals from 49 to 77 days (the latter being full maturity in that season) from flowering. Green boll samples were opened and the contents sun-dried. Sufficient lint was obtained from each sample to make spinning tests possible.

The second set of samples comprised a dated boll series picked at 5-day intervals from 20 days to 70 days (full maturity) from scattered plots of U.4/5143 in this season. This collection was made at the request of the Shirley Institute; unfortunately the request arrived in January, too late for it to be possible to provide a properly randomized

set of samples. The 20-, 25- and 30-day samples were not fit to gin and were sent as seed cotton ; the remainder yielded 55 to 75 gm. of lint each, plus 20 gm. seed cotton which was sent unginned.

In the coming season it is hoped to collect 200–300 gm. samples of lint, at 5-day intervals from 35 days onwards, on a fully randomized basis. Samples will also be collected from 20-, 25- and 30-day bolls, but it is not anticipated that these will produce material suitable for ginning. The collection should, however, provide more comprehensive material suitable for investigation of hair characters at different stages of lint development, as well as for small-scale spinning tests, than that available from the 1943–44 crop.

Soil Structure and Grass Rests.—These two experiments, details of which are given on page 31 of the Progress Report of 1943–44, are being continued. Soil samples from both experiments have again been forwarded to Dr. W. S. Martin, of the Kawanda Agricultural Research Station, Uganda, who has very kindly undertaken to carry out examinations of the structure on annual samples from both experiments.

PROGRAMME OF WORK FOR 1945-46.

Cotton Breeding.

Variety Trial.—The thirteen U.4/5143×Cambodia and ten U.4/8161×M.U.8 strains which gave the best yields in previous seasons' trials will be tested against the best U.4 strains, in a balanced incomplete block trial. It is hoped to send lint samples of these strains for spinning tests.

Hybridization.—Work will be continued on the material described in the present Report. Over 800 single plants and a large number of bulks have been carried forward.

A large number of single plants will be grown, selected in the past season for the longest hairs, irrespective of other characters, that could be found in the available material. These will be utilised both for straight selection work for long hair characters, as well as for crossing with a range of other very hairy strains, as a preliminary to investigating the possibility of very long haired types being resistant to *Lygus* attack.

Hairiness and Jassid-Resistance.—In view of the conclusive results now obtained on this subject, further work will be confined to a few points only on which further evidence is desired. Of these the chief is the effect on hairiness of climatic conditions, water supply, soil

fertility and locality. It is hoped to compare the hairiness of A.2106 grown under varying conditions at Barberton and at Ukiriguru in Tanganyika.

Further analysis of the extensive data from last season's experiments will occupy part of the coming season.

EXPERIMENTS.

A randomized block experiment to provide U.4 lint samples, from dated bolls, taken at 5-day intervals from 20 days after flowering until full maturity, will be planted. The samples will be forwarded to the Shirley Institute for use in their investigation in the problem of fineness.

Soil Structure and Grass Rests.—The experiment to test the effect of resting crops of Napier and Rhodes grasses on the red loam soil now in its third year is being continued.

[*Included by courtesy of the Southern Rhodesia Government.*]

SOUTHERN RHODESIA
SEASON 1944-45.

Introductory Note

BY

G. S. CAMERON.

Chairman, Cotton Research and Industry Board.

The following report, compiled mostly by Mr. McKinstry, covers a season which, from the point of view of cotton investigational work, was possibly the most exasperating in the history of the Cotton Station at Gatooma. On the other hand it emphasised again, if such emphasis is necessary, the adaptability of cotton to varying seasons ranging from very dry to very wet. The most pleasing feature of the season was that, for the third year in succession, the crop yielded a high percentage of "good colour" cotton as there was very little discolouration due to stainer damage. The cause of this state of affairs cannot be stated definitely, but it may be connected with the strict observance of a close season. It became necessary, during the course of the year, to import a certain amount of "off colour" cotton in order to tone down Rhodesian yarn which otherwise would have been too bright for local requirements.

Although cotton prices may now be regarded as satisfactory, recently they have been outstripped by the price of maize. This fact, together with the need to devote a larger acreage to growing food for Britain, is likely to affect any immediate increase in cotton production.

The following tabular statement shows at a glance the approximate periods of the important developmental phases of the crop in comparison to what may be called a "normal" season. It should be noted, however, that a "normal" season seldom, if ever, occurs.

	Normal Season.	*1944-45 Season.*
Planting Period	Mid-November.	Planted dry mid-November but no brairds until 2nd half of December.
Flowering Period	End Feb.-early March.	Late March-early April.
Picking Period	May-June.	June-July.
Close Season	30th September.	30th September.

The area of cotton harvested this season was approximately 4,524 acres. The average yield is estimated to be 108 lb. lint per acre. A larger acreage would probably have been sown had it not been for the paucity of the planting rains in November and December. These consisted mainly of light and ineffective showers and, on certain farms, acreages had to be abandoned on that account. In several instances

rains in really satisfactory amounts did not fall until early January. Fortunately, however, the season has been one of light insect damage to cotton. The overall yield in the plant breeding plots at Gatooma, where plant stands averaged about thirty to forty per cent., was about 100 lb. lint per acre. But yields calculated on sample rows in the bulks, where stands were of the order of fifty to sixty per cent., worked out at 200–300 lb. lint per acre.

This year, as a further improvement in marketing, the crop was purchased as seed cotton, in four classes only, delivered at the ginnery. Formerly it had been purchased on grade, as lint. With seed cotton as the basis, payment due to the farmer was expedited. The price range was from 32/– per 100 lb. for clean white seed cotton, to 18/– per 100 lb. for the lowest or fourth class. The new system worked satisfactorily.

Another service to the farmer, developed in recent years on a commercial scale, is the supply of sulphuric acid treated cotton seed for planting. This seed costs about double the price of the ordinary machine-delinted seed, but only about half the quantity is required to sow an acre. There is a big demand for acid-treated seed as farmers increasingly realise that it possesses the distinct advantages of better germination and ease of handling at planting.

A possible further improvement in the seed supply now contemplated is the treatment of planting seed with a fungicide. Such treatment will depend on the results from certain experiments to be undertaken at the Cotton Station next season.

Mr. A. H. McKinstry joined the staff of the Cotton Research and Industry Board, in February, 1945, after his return from Tanganyika Territory.

COTTON RESEARCH STATION, GATOOMA.

PROGRESS REPORT FOR THE SEASON 1944-45

BY

A. H. MCKINSTRY.

Part I.

Meteorology.

The total rainfall at the Station for the period 1st November to 30th April was 24·31 inches. Rains were sparse and largely inadequate in November and December, totals of 1·70 inches and 1·99 inches respectively being registered for these months. No shower of more than 0·40 inches fell during November, and only two of just on 0·50 inches were recorded in December. In fact moisture conditions were insufficient until the first week of January, 1945. Thereafter, rains were good and well-distributed until they finally ended for all practical purposes on 19th March with a fall of 2·55 inches.

Weather conditions were generally wet and overcast for two periods of a few days during the first three weeks of March, and, although the taking of records in the field was handicapped on these occasions, the general trend in the picture of plant development and pests incidence was easily discernable.

Wintry weather in June, July and August, this year, was prolonged, and some of the lowest temperature minima for many years past were registered on different occasions. Isolated cases of frost damage to cotton were reported from the colder districts. This occurred mostly over small areas in low-lying lands.

Agricultural System.

Soils.—Soil fertility at the Station for a number of years past has been maintained at a high level by a system of mixed farming. This embraces the growth of maize, cotton, and sunnhemp, and the making of compost for which bullocks are bought and fattened yearly. Cotton and maize yields are among the best in the district, although a proportion of the Station's soil is poorer than on many farms in the neighbourhood.

Despite this apparent satisfactory position in the agricultural system, it is proposed in future to investigate the possibilities of further improving yields by the use of temporary grass-leys. In 1945–46 a start will be made by putting under observation blocks of a number of grasses. It will also be possible to observe the results of planting cotton and maize in blocks on a narrow strip of land which has been under "Woolly Finger" grass for five years.

Agricultural Practices.

All cotton planted this season followed maize in the rotation, and as is customary practice, all lands due for cotton received an application of 5 tons of compost per acre before they were ploughed and rolled in the winter months.

As in the previous five seasons, the crop was dry-planted, this season over the period 11th to 18th November, except for a small acreage which was sown on 23rd November. The seed was sulphuric acid delinted, and it was spaced, at fairly heavy seed rates, at a uniform 12″ × 42″ in the bulks and three strain trials.

A preliminary experiment was carried out, in which plants were "topped" by cutting away the tops of the main stem and large monopodia at a height of about 2 feet from ground level on 26th March. This experiment was designed with the aim of noting plant response, as well as the effect on stainer populations of any reduction in shade caused by topping; no new vegetative growth was produced this season. It was further observed at harvest that bolls on the topped plants appeared to have burst more healthily, and that the seed cotton was comparatively free of leaf trash. While it is not

suggested that topping might become a routine agricultural practice, it may be mentioned that several farmers are attracted by the possibility of thus reducing trash in the seed cotton.

Cotton Plant Development.

As has been stated previously, weather conditions for germination were probably the most difficult on record. A proportion of the seed germinated on very light showers at the end of November, but the majority of these young seedlings died off, because of the dry conditions which followed and which lasted for the first twelve days in December. Germination of the remainder of the seed took place after the fall, about mid-December, of slightly heavier showers which totalled 1·38 inches over a three-day period. It is mostly from plants of this second braird, on which, incidentally, little rain fell before the first week of January, that the Station's crop has been picked.

Despite the very difficult start, final plant growth was good to very good, but plant stands were only 30 to 40 per cent. of a full stand.

Flowering in the crop commenced about the middle of February, and was at its peak of slightly over one flower per plant per day over the period late March and early April. From the way in which total bud and boll shedding increased markedly after the end of March, it may reasonably be inferred that the major portion of the crop reaped was set before that time, *i.e.*, during the first five to six weeks of flowering. In the earlier and very much smaller shedding which occurred before the end of March, Sudan bollworm accounted for practically the whole of the total shedding. These sheds were from the earlier and lighter flowering and proportionately they were less than the total sheds from the heavier flowering at, and subsequent to, the end of March.

Of the total buds and bolls shed after this period, about two-thirds were lost through bollworm damage, probably mainly to American bollworm attack. (See section on Insect Pests.) What proportion of the remaining third, or the non-bollworm fraction, of these later sheds might have been due to declining moisture conditions or to other insect agencies is not known. Bolling records show that the crop matured over the period mid-May to mid-July. In practice it was taken at the one commercial picking.

Cotton Breeding.

Differences between strains for jassid-resistance could not be assessed by the amount of jassid damage, as there was little evidence of the symptoms typical of jassid attack. (This may be due to the high degree of resistance in all cottons now retained as breeding

material). To that extent only was the work of selection handicapped ; for plants bore satisfactory crops of almost stain-free cotton under the current attacks by bollworm and cotton stainers. Thus it was possible to take about three hundred single plant selections, of which probably a third will merit being planted.

The ancestry of the present strains bred at Gatooma by continuous selection is traceable to two main family groups, namely, U.4/64/7/10 and U.4/64/V. These strains were taken as selections in 1930 ; and they were both issued to growers in the 1932–33 season. They replaced in commercial cultivation their parent U.4/64, which was one of the first selections out of the original lot of U.4 Mixed Bulk seed obtained from Barberton and grown at Gatooma for the first time in the 1927–28 season.

In its day, in seasons 1932–33 to 1935–36, U.4/64/7/10 definitely set and matured earlier crops than U.4/64/V, but on the other hand U.4/64/V was noted for its better degree of jassid-resistance, and for the superior character of its lint. However, U.4/64/V itself was finally discarded in 1936 on the count of its being a comparatively late cropper ; but 64/V families which had been selected for earliness were grown on in subsequent years.

Of the two strains at present in commercial cultivation, 9L18 (issued for multiplication in 1942–43) and 9L34 (issued for multiplication in 1943–44), 9L18 is descended from U.4/64/7/10 families, whilst 9L34 is derived from a U.4/64/V family.

In last season's report a doubt was expressed as to whether 9L34 would prove to be a better yielder than 9L18. Reports which have so far been received indicate that there is little to choose between these strains in the matter of yield performance this year, one in which bollworm damage seems to have taken its main effect about the middle and top crops on the plants. On the question of lint quality, however, 9L34 and related strains easily lead the field, not only against 9L18 and other families derived from U.4/64/7/10, but even more so against the large group of Gatooma cross-bred strains. Previously selections from them have had the prefix " 7C ". A number of these strains have given consistently high yields in variety trials on the Station over the past three seasons, but their lint judged by present standards is short. Their jassid-resistance, however, is high.

Though statistically there are no significant differences between the seven strains tested, in one of the strain trials it is of interest to note that 9L18 and 12348, (a 9L34 selection), and 12490, (a selection from a 7C family), in that order gave the highest yield of lint per acre. The two other strain trials were abandoned.

The following are some of the more recent Gatooma-bred strains, their important U.4.-derived ancestry, and their main characters.

From among these, it is expected that further improved seed issues (and selections) will be made.

Analysis of Important Gatooma Strains on Samples of "Sound Bolls" taken in Bulks.

Family Group as indicated in text.	*Strain Number.*	*Boll Weight Grms.*	*Seed Weight per 100 seeds, Grms.*	*Lint Index per 100 seeds, Grms.*	*Ginning %*	*Lint "Effective Length" Baer 32nds inch.*
64/7/10	12219	4·5	9·7	5.1	34·5	32
	1222	5·0	9·6	5·8	37·5	34
	12231	5·1	9·3	5·5	37·4	32
	9L18	4·4	8·6	5·1	37·1	31
64/V	9I.34	4·8	11·1	5·3	32·2	35
	12348	4·7	11·2	5·8	34·1	34
	12347	5·6	13·7	6·7	32·8	38
	12438	5·0	10·9	5·5	33·6	34
64/7/10 derivatives × Cambodia × 64/7/10 derivatives.	12405	5·4	10·4	5·9	36·0	30
	12204	4·9	9·8	5·2	34·6	30
	12490	5·4	11·6	6·1	34·4	32
	12215	5·4	10·0	5·6	36·0	32

Six Barberton cross-bred strains having either Cambodia or MU8A as the one parent with Barberton U.4 as the other were grown in observation plots for the second consecutive season. Those with Cambodia parentage made a very promising beginning, both in style of growth and early flowering. During the course of the season, however, they appeared to shed their crop readily. Compared with Gatooma U.4 strains they made large growth and yielded poorly. But as these strains have a high degree of jassid-resistance with good quality lint, they will be grown again for still further observation.

Cotton Pests.

Jassids.—Counts of jassid nymphal populations showed these to be small. Further, at no time during the season were the characteristic symptoms associated with jassid damage apparent to any extent. Plant selection work has therefore been done this year virtually in the absence of jassid attack.

Sudan Bollworm.—As usual the final small fraction of moths emerging from over-wintering pupæ gave rise to the first generation of larvæ which attacked young squares and flower buds before the plants had started to flower, in mid-February. Further, in the comparative absence of damage by other major pests during the first few weeks of flowering, Sudan bollworm was most probably responsible for almost the entire loss of buds and young bolls. The attack by this pest continued throughout the season. In numbers total larval populations averaged about 1 larva to every 3 to 2 plants, until about the end of March. Populations then declined slightly until the end of April, after which they increased to a peak of 1 larva to every 2 to 1·7 plants during May. From the end of May populations started to decline and, by the end of June few larvæ could be found.

The attack by this pest may be regarded as being persistent throughout the season, and of greatest account in the loss it caused to the early crop of young buds and bolls.

American Bollworm.—Composite larval populations of this major pest started to increase markedly soon after mid-March, and their damage was reflected shortly afterwards in the marked increase of bollworm-punctured bud and boll sheds. After the middle of March larval populations increased steadily until they reached their maximum number about mid-April. Thereafter, the attack waned and by mid-May few could be found. At the peak period of the attack, during most of April, there was about 1 larva to every 2 to 1·3 plants. In magnitude and duration this season's attack was slightly greater than those of the previous four seasons, but it was most definitely of very much less weight than the infestations which occurred in the seasons 1934–35 to 1939–40 inclusively. The damage done by this year's attack, although quite evident, was confined mainly to the potential upper-middle and top crops. The crop harvested came mainly from the setting of the earlier flowering which took place before American bollworm seriously commenced to attack in the latter half of March. That this attack did not develop with greater force on the earlier flowering is probably due to the fact that maize crops in full tassel soon after mid-February definitely attracted much of the egg-laying at that time.

Spiny Bollworm.—This bollworm was present in small numbers throughout the season, and particularly during April. To it is attributed a small portion of the crop lost.

Cotton Stainers.—Only a very occasional immigrant stainer was found in the crop earlier than the end of March, and even then the population numbers remained small for several weeks. For instance, total adult populations amounted to only 1 adult to every 5 plants at the end of April. At the end of May stainers were most numerous for this season, about 1 stainer then being found to every 1·25 plants. Afterwards numbers declined and few were to be seen at the end of June.

For all practical purposes it can be said that populations were composed entirely of *D. fasciatus* and *D. intermedius*. The latter were the more numerous until mid-May, but thereafter *D. fasciatus* greatly predominated in the total numbers. Judged by fifth instar nymphs, *fasciatus* as usual bred up more readily and rapidly. The first of the fifth instar nymphs was recorded in May.

Stainer damage to the crop as a whole was light. On the Station, about eight per cent. by weight of the seed cotton showed varying degrees of staining, most of which was light.

Aphis.—On the 13th February it was noted that aphis was present on isolated groups of plants. This attack did not develop. It may have been dispersed by rainfall which was plentiful at the time, especially during the first ten days of March. Later, about the first week of April, aphis was again observed to be in the crop. This

infestation did develop markedly during April and in early May. During its course leaves became sticky with honey-dew, and it is possible that this factor caused premature senescence of the nearly mature leaves. But it is unlikely that yield was thereby affected.

Termites.—Damage by these insects was not of much account in reducing crop yields. This is deduced from the fact that there was no appreciable reduction in plant stands in the randomised sample rows, scattered over practically the whole area, on which records were taken throughout the season.

Root Knot Nematode.—Last season's report referred to the fact that Mr. R. W. Jack was very kindly investigating the susceptibility of 9L34 to root knot nematode at the Tobacco Research Station, Trelawney. It was then stated that results obtained in August, 1943, and again in May, 1944, indicated that this strain of cotton was highly resistant to the nematode. In a letter dated as recently as 6th September, 1945, Mr. Jack in reference to this subject states :—

" In brief, I have not only not been able to induce any infestation in plants of this strain, but have obtained evidence that a crop of it has a marked effect in reducing the nematode population in the soil. In fact, on the class of soil and under conditions of the season concerned, this reducing effect was markedly better than that of sunnhemp, which has, of course, a world-wide reputation in this respect."

Thus the apprehension which had been evinced in tobacco circles with regard to the possibility of cotton-growing leading to an increase of nematode in the soil is dispelled, at least with the strain 9L34.

Arrangements to test a number of other strains for susceptibility to nematode are being made in conjunction with Mr. B. L. Mitchell of the Trelawney Tobacco Research Station.

Mycology.

About the end of February and early in March, when moisture conditions were good and plant growth was lush—without necessarily being sappy—groups of plants in a few related strains were noticeably infected by *Alternaria macrospora*, which organism was identified by Dr. J. C. Hopkins, Senior Plant Pathologist, Salisbury. The infection did not develop to any extent on the Station. A few crops on farms in this district were similarly affected.

Angular leaf spot lesions occurring on a small scale were noticeable during the earlier stages of flowering in the crop.

Summary and Conclusions.

Sparse and very inadequate rainfall in November and December was responsible for poor plant stands in cotton. This was the most important factor limiting yields per acre on the Station and elsewhere.

The crop was dry-planted mainly over the period 13th to 18th November ; it started to flower about mid-February and was at its flowering peak during the latter part of March and early in April ; it matured principally over the period mid-May to mid-July.

Crop loss previous to and during the first few weeks of flowering was largely due to attack by Sudan bollworm ; but the more evident and greater damage was caused by American bollworm from about the end of March. That this latter was not more pronounced is attributed to moderate-sized American bollworm populations, and to the fact that maize in full tassel about mid-February took a good proportion of the early egg-laying just previous to the time that cotton was about to commence flowering. Thus the importance of having the crop as early as possible is once again confirmed.

Jassid damage was negligible.

Cotton stainers did only a small amount of damage, indirectly, to the seed cotton. Certain preliminary experiments aimed at the control of these pests are reported in Part II.

Pedigrees and important characters of present-day Gatooma U.4 strains, some of which will probably be issued for commercial cultivation, are listed.

Mention is made of improved services to cotton growers in respect of the marketing and the seed supply of the crop.

PROGRESS REPORT—PART II.

Cotton Stainer—Control Experiments.

Stainer populations, staining of the seed cotton, and yield were recorded for both " topped " and " not topped " plants in the experiment to which reference has already been made under " Agricultural Practices ". Plants were topped, as already described, on 26th March. The following results are of interest :—

(1) Adult stainer populations showed a slight, but definite, tendency to be smaller in the topped plots after mid-April. Before that time, when the crop was younger and more vulnerable to Internal Boll Disease, no such definite trend was noticeable.

(2) Fifth instar nymphs were less numerous in the topped plots until the end of May, but during June definite differences between the two treatments were not readily discernable : the crop was then maturing rapidly.

(3) There were no differences in the amount of stained seed cotton, both treatments having 8% of stained cotton in this season of light stainer damage.

(4) Yields of the topped plants were at the rate of 174 lb. lint per acre, with a 36% plant stand, and of the not topped plants 158 lb. lint per acre with a 31% plant stand. The significance of these differences, if any, has not been assessed.

In another experiment, sugared solutions of sodium arsenite in water applied by the " mop " method at weekly and fortnightly intervals, and of sodium fluosilicate applied weekly were tested as possible control measures against stainers. Control plots receiving no treatment were also part of the experiment. The poisoned solutions were first applied on 27th March.

Yield results are not statistically significant, but both the sodium arsenite weekly and fortnightly applications yielded appreciably less lint per acre, that is, 74 lb. and 101 lb. respectively than either the control or the sodium fluosilicate treatments in both of which cases the yield was 132 lb. lint per acre.

The amount of stained seed cotton in the control or untreated plots averaged 9%, this figure is about 2 or 3% higher than those for other treatments.

It seems probable from Prentice's observations at Shinyanga, Tanganyika, where similar experiments have already been carried out, that the reason for the low yields recorded with the arsenite treatments as contrasted with the better yield of the control is due to the fact that the poison was applied in fine rather than coarse droplets with the type of mop used. The defect will be remedied when the experiment is repeated next season.

In the matter of dead stainers collected at intervals of a few days in the different treatments, the most positive indication was that quite fair numbers of adults—as judged on percentage numbers dead on the totals collected for each individual treatment—were killed with the sodium arsenite treatments, particularly when the arsenite was applied in weekly doses. By comparison the sodium fluosilicate solution killed few adults. Similarly the sodium arsenite weekly application killed most fifth instar nymphs.

Preliminary laboratory experiments with D.D.T. (Technical strength) and stainers demonstrated that these pests die readily after slight contact with the insecticide in the form of dust.

ANGLO-EGYPTIAN SUDAN.

PROGRESS REPORT OF THE PLANT BREEDING STATIONS, SEASON 1944-1945

BY

R. R. ANSON, R. L. KNIGHT AND S. H. EVELYN.

PLANTING AND PICKING DATES.

Area.	*Average Planting Dates.*	*Average Picking Dates.*	*Close Season.*
Gezira ...	10th Aug.–15th Sept.	30th Dec.– 1st April	15th April–10th Aug.
Gash Delta	20th Aug.–20th Sept.	10th Jan.–30th April	30th April–20th Aug.
Tokar	7th Sept.–15th Oct.	1st Jan.–31st May	1st June–20th Sept.
Kadugli/ Kordofan	15th June–15th Aug.	15th Oct.– 1st Mar.	1st Mar. –15th June
Talodi/ Kordofan	15th June–15th Aug.	15th Oct.– 1st Mar.	1st Mar. –15th June

Meteorological Note.—In nearly all districts rain fell early in May and showers were well distributed throughout the season.

INTRODUCTION.

This season, the practice of writing separate reports for the Gezira, Shambat and Kadugli has been reverted to. As before, Mr. Anson has been responsible for administration of the Section, for all cotton varietal testing, plant propagation and for the supervision (as far as possible) of Kadugli Station. Mr. Evelyn has been responsible for all selection work on cotton and sorghum in the Gezira and for all statistical work, and Dr. Knight has carried out all hybridization and genetical work. The provision by the Corporation, next season, of a plant breeder for Kadugli will make a great difference to the value of the Plant Breeding Section as a whole and if at the same time a Plant Propagation Officer is forthcoming from the Sudan Government, this will take a further load off Mr. Anson's shoulders.

During February the Sudan was visited by Mr. J. B. Hutchinson, C.M.G. We found this visit most stimulating and hope, in future, to see more both of Mr. Hutchinson and of the other members of the Corporation's staff and of their Scientific Advisory Committee. The value of contacts such as these cannot be too highly stressed.

For details of the agricultural background of the Sudan cotton areas the reader is referred to the 1943–44 Report. Details of plant breeding problems are also given in the Introduction to the 1942–43 Report, and a key to varietal and genetic symbols will be found at the end of this Report.

THE GEZIRA STATION

BY
S. H. EVELYN.

Egyptian Cotton Breeding.

Introduction.

The previous report(1) dealt mainly with the agricultural background of the areas for which breeding work was being performed and as a consequence continuity in the account of the progress of the Egyptian cotton breeding work was interrupted. This report has been designed to fill those gaps and to give a short story of the work on each of the main varieties. This, it is hoped, will enable the reader to understand more clearly what is aimed at and what has been accomplished.

The breeding policy as outlined in the two previous reports(2) has been followed and improved by having spinning tests performed on all promising material produced in the breeding plot, through the kindness of the authorities in charge of the Test Mill at Giza, Egypt. Fifty samples from the 1943–44 breeding plot were tested at the Giza Mill for the first time and the results of these tests have greatly influenced subsequent selection. Because of this it has been decided to record these results which were not available for inclusion in last season's report.

Before dealing separately with the main Egyptian varieties on which selection is being practised, one point of interest is worthy of note. Most of the samples submitted for small-scale spinning tests were chosen as a result of a combination of (*a*) the laboratory analysis of such major characters as seed cotton, lint and number of seeds per boll, mean yield of seed cotton per tree, lint index, seed weight, G.O.T. and (*b*) from the " feel " of the lint during combing and measuring. Such " feel " was described by the measurer as Very Excellent, Excellent, Very Nice, Nice, Fair, Coarse, and it is interesting to record that agreement between these descriptions and spinning values as expressed by hair weight, staple length and lea product, was obtained in 49 of the 50 samples submitted.

This section of the report deals mainly with the Gezira Station and covers the improvement by selection, of yield, plant uniformity, staple regularity and quality, early maturity and resistance to leaf curl, and the varietal testing and propagation work.

Domains Sakel.

It will be remembered that in the 1942–43 season(3) 268 typical random plants from a nucleus field at the Barakat Seed Farm were analysed and 43 of them which passed a " purity " test were grown as separate progeny rows the following season. Fourteen others which showed improvement in major characters were also observed

(1) For references see p. 48.

in progeny rows. Of these, twelve were considered from the analytical data and "feel" to merit small-scale spinning tests and were sent to Egypt along with a bulk sample of 13 of the best "purity" rows and a control sample of that season's commercial Domains Sakel grown in the Breeding Plot.

Report of the Spinning Test Mill at Giza, Egypt. 22/1/45.

	Domains Sakel Samples Grown in the 1943/44 Breeding Plot at G.R.F.	*Hair Weight per cm.*	*Staple Length, (32nds inches)*	*Mean Length (inch)*	*Lea Product (60's Cdd.)*
1.	Dom. Sak. COMMERCIAL CONTROL D.8.S.F.	137	51	1·15	2,640
2.	BULK from P.R.'s—1, 2, 4, 6, 7, 13, 14, 20, 23, 26, 27, 42, 43...	137	50	1·14	2,810
3.	P.R. 16/43	136	52	1·15	2,855
4.	„ 24/43	143	51	1·13	2,685
5.	„ 28/43 PURITY SELECTIONS	142	52	1·21	2,795
6.	„ 31/43	130	52	1·21	2,955
7.	„ 34/43	137	52	1·19	2,850
8.	„ 37/43	138	51	1·17	2,735
9.	„ 44/43	142	51	1·19	2,735
10.	„ 46/43	138	54	1·24	2,965
11.	„ 47/43 IMPROVEMENT SELECTIONS ...	144	52	1·16	2,780
12.	„ 48/43	139	53	1·19	2,755
13.	„ 50/43	127	51	1·20	2,890
14.	„ 57/43	128	50	1·15	2,840

(*a*) The above are composite samples including all pickings.

(*b*) The mean variance arising from spinning test factors alone was 2,200, equivalent to a standard error of 47 lea product units.

(*c*) On yarn strength and staple measurements alone, the spinner considered Nos. 10, 6 and 13 the best cottons in that order. It is interesting to note that by "feel" No. 10 was also considered the best.

(*d*) All selections gave stronger yarns than the control and some of them were finer; this fineness was not due to immaturity.

(*e*) Sample 2 only differed from the control by its higher yarn strength. Selfed seed of this sowed two acres in isolation at the Barakat Seed Farm this season and gave a seed cotton yield of 2,211 lb. per acre. This will establish, in isolation, 60 acres at the Seed Farm and 150 acres at the Gash, next season. The unselfed seed was tested at Barakat against the Commercial Control, X1730A, BAR.N.T.2/41 and BAR.X1730L this season and significantly outyielded them all in seed cotton and also in lint, with the exception of X1730A, which with its 3·3% higher G.O.T. reduced the lint yield difference to insignificance. Samples of this material have been submitted for spinning tests.

(*f*) Selfed seed of the 13 progenies of Sample 2 was grown as 13 separate bulks this season and gave excellent results. The six with parental hair weights of 138 and under and lea product values of 2,840 and over will be bulked to enter the 1945/46 variety trials and their selfed seed will be again sown as separate bulks to await the results of this season's spinning tests before deciding on the ones to be selected for bulking in isolation.

In addition to this work of purifying and improving the plant and staple regularity of commercial Domains Sakel, 53 single-plant selections showing improvement mainly in lint per boll, lint index and total seed cotton per plant, were grown and analysed. Their parents all had low hair weights and high lea product values. Results showed that these progenies maintained the good characters of their parents and many of them are being carried forward for further improvement.

The advantage of early maturity has already been mentioned in a previous report.(4) Invariably the earliest picked cotton is of the highest grade and the grades get progressively lower with each picking so that the last picking is generally classified as grade 6—the lowest grade. If, therefore, a strain could be obtained which matured the majority of its crop in, for example, grades 1, 2 and 3, such a strain would produce a higher cash return than later-maturing strains, all other characters being equal. A low mean number for the first fruiting node is strongly indicative of earliness and so node number counts were recorded for each plant of the 53 progenies grown this season. Individual plants ranged from 7 to 17 and progeny means

from 9·44 to 12·08. Plants with a node number of 8 in the three progenies with the lowest means have been selected for further study. As a check on this work the total number of matured bolls and the date of last picking per tree are recorded seasonally.

Next season the weight of seed cotton per tree will be recorded for each picking so that each picking can be expressed as a percentage of the total yield. The results this season appeared very promising.

BAR.N.T.2.

The N.T.2 strain, originally found by Mann in the Gash and later improved by Trought and King, was considered at one period as a probable substitute for Domains Sakel because of its high yield and leaf curl-resistance. The strain is, however, coarser and weaker than Domains Sakel and for these reasons both N.T.2/36 (of mixed lint colour) and later N.T.2/38 (the brown-linted component of the N.T.2/36 mixture) never found favour commercially. Since Blackarm-resistance has been added to N.T.2, differences between the BAR strains and the N.T.2 parents have been so slight that it was decided last season to concentrate on the former and only maintain the best N.T.2 strain as a parent for future backcrossing. The BAR.N.T.2 strains are superior in lint quality to commercial X1730A and it was now thought that one of them might replace X1730A, so with this object in view selection has been carried out to purify the type, increase yield and improve staple regularity. In the 1942/43 season 182 random plants of BAR.N.T.2/41 grown in the Breeding Plot at the Gezira Research Farm were analysed and 54 selections grown as progeny rows the following season. Lint samples of the best of these were sent to Egypt for small-scale spinning tests along with parent controls and later backcrosses containing the $\mathbf{B}_2$ and $\mathbf{B}_3$ factors for Blackarm-resistance.

REPORT OF THE SPINNING TEST MILL AT GIZA, EGYPT. 22/1/45.

N.T.2 and BAR.N.T.2 Samples Grown in the 1943/44 Breeding Plot at G.R.F.	*Hair Weight per cm.*	*Staple Length (32nds inches)*	*Mean Length (inch)*	*Lea Product (60's Cdd.)*
15. N.T.2/39 GENERAL—(PARENT OF BAR Progenies) ...	149	54	1·18	2,475
43. N.T.2/39 P.R. 221/43—NEW PARENT FOR BAR work ...	153	54	1·20	2,655
16. BAR.N.T.2/41—(7th B/C $\mathbf{B}_2\mathbf{B}_2$)	154	54	1·17	2,535
18. P.R. 114/43	150	55	1·21	2,555
19. „ 119/43	152	54	1·20	2,695
20. „ 124/43	149	55	1·23	2,500
21. „ 126/43	150	55	1·25	2,485
22. „ 129/43	152	54	1·18	2,775
23. „ 132/43 SELECTION FROM BAR.N.T.2/41 ...	145	55	1·24	2,660
24. „ 133/43	150	55	1·21	2,565
25. „ 136/43	150	56	1·26	2,710
26. „ 143/43	144	56	1·22	2,685
27. „ 146/43	151	55	1·22	2,630
28. „ 156/43	145	55	1·21	2,790
29. „ 166/43	151	55	1·21	2,535
30. Bulk of Samples 18 to 29	143	56	1·22	2,635
17. BAR.2/10—P.R. 167/43 (9th B/C $\mathbf{B}_2\mathbf{B}_2$)	147	55	1·26	2,520
46. BAR.2/12—P.R. 169/43 (6th B/C $\mathbf{B}_2\mathbf{B}_2$)	146	55	1·22	2,505
47. BAR.6/5—P.R. 171/43 (10th B/C $R_2^{RS}R_2^{RS}\mathbf{B}_2\mathbf{B}_2$)	161	54	1·22	2,530

(*a*) The above are composite samples including all pickings.

(*b*) The mean variance arising from spinning test factors alone was 2,200, equivalent to a standard error of 47 lea product units.

(*c*) On yarn strength and staple measurements alone, the spinner considered Nos. 28, 22 and 25, and 26, the best cottons in that order, although all samples were generally weaker and longer than the Domains Sakel samples. On "feel," No. 28 was also considered the best of the N.T.2 samples submitted.

(*d*) All samples were stronger than the parent control (No. 15) and some of them finer and slightly longer.

(*e*) Sample 30—was a decided improvement on sample 16 and outyielded it in this season's variety trial.

(*f*) The selfed seed of samples 18 to 29 was sown as separate 100-plant bulks in this season's breeding plot and on analysis gave promising results. Lint samples have been submitted for spinning tests to determine which of these are to be bulked to form a nucleus for seed multiplication. Node numbers were recorded for each plant of these progenies and ranged from 10 to 18 with progeny means of 11·79 to 13·38. As N.T.2 is later maturing than Domains Sakel, low node number selections are being studied with the object of producing earlier maturing varities.

(*g*) Seed of sample 30 was only sufficient to be tested in a varietal trial at the Research Farm this season and, although seed cotton differences did not reach significance, this selected BAR.N.T.2/41 was only outyielded by N.T.2/39 by 2%, but outyielded selected BAR.X1730L (1%); X1730A (1%); BAR.N.T.2/41 Gen. (4%); Domains Sakel (5%); BAR.4/5 (7%); BAR.4/8 (7%) and BAR.X1730L Gen. (7%). In lint it was significantly outyielded by selected BAR.X1730L (13%) and X1730A (11%) mainly because of their much higher G.O.T.'s.

(*h*) As lint yield and G.O.T. are two of the major factors affecting the replacement of X1730A by the better quality BAR.N.T.2, the 10 single-plant selections that are being carried forward were chosen for high lint index, seed cotton and G.O.T. from within progenies with low parental hair weights and high lea product values. Of the 182 random plants analysed in the 1942/43 season only three now remain in the Breeding Plot.

(*i*) It was observed in the ginning of the BAR.N.T.2/41 this season that bits of the seed-coat plus fuzz were torn off by the gin knives and mixed with the lint, giving it a speckled, dirty appearance. This disadvantage appeared to be associated with seeds with a large amount of long fuzz and was reproduced in the laboratory by hand-pulling. Strains with short, scarce fuzz are now being selected wherever possible.

In addition to the BAR.N.T.2/41 progenies (*i.e.*, 7th backcross $\mathbf{b_1b_1B_2B_2}$ composition), further backcrosses with the $\mathbf{B_2}$ resistance gene and others carrying the $\mathbf{B_3}$ gene from *G. punctatum* were studied in progeny rows, and lint samples obtained for spinning tests. These later backcrosses, particularly those carrying $\mathbf{B_3}$, have been made to "purer" parents and it seems from "feel" that the lint quality is better. Lint indices and G.O.T.'s are also in general higher, and many selections are being carried forward for further study.

Two F_2 families of 5th backcross—BAR.898 × N.T.2/38 were grown and analysed this season. BAR.898 is of Sea Island origin and is the only *G. barbadense* strain known to carry the $\mathbf{B_2}$ factor for Blackarm-resistance. N.T.2/38 is highly resistant to leaf curl disease at Shambat and in the Gezira. Both families bolled heavily and gave high yields of seed cotton, had high lint indices and G.O.T.'s associated with good quality lint and the seed was almost devoid of fuzz. Selections are being carried forward.

In concluding this section the point should be stressed that for obvious reasons we do not consider it economical or good policy to introduce a third commercial strain in the irrigated Gezira. Our aim, therefore, is to continue selection work on BAR.N.T.2 until it has reached the stage of outyielding X1730A in lint and then, because of its superior lint quality and its resistance to Blackarm and leaf curl, the question of its replacing X1730A may come up for serious consideration.

BAR.X1730.

In the irrigated Gezira and in the Gash and Tokar, X1730A is the only other commercial cotton grown besides Domains Sakel. It is poorer in quality and much later maturing than Domains Sakel but, because it is higher yielding, is resistant to leaf curl under Gezira conditions, has the habit of growing away from Blackarm disease and is easily marketable, it constitutes about half the Egyptian cotton area grown annually, particularly where Blackarm and leaf curl diseases formerly took a heavy toll of the Domains Sakel crop.

As selection work in the period 1931–42 had failed to produce any X1730 strain showing sufficient improvement to justify replacing X1730A, it was decided in the 1942/43 season to concentrate on the BAR.X1730 material and only maintain a pure culture of X1730K as parent for the Blackarm backcrossing work. In this season 378 random plants of BAR.X1730L (7th backcross—$\mathbf{b_1b_1B_2B_2}$) were analysed and 55 of them grown as progeny rows in the 1943–44 season. Lint samples of the seven best of these were sent to Egypt for spinning tests, along with controls and samples from later backcrosses.

REPORT OF THE SPINNING TEST MILL AT GIZA, EGYPT. 22/1/45.

The X1730 Samples Grown in the 1943/44 Breeding Plot at G.R.F.	*Hair Weight per cm.*	*Staple Length (32nds inches)*	*Mean Length (inch)*	*Lea Product (60's Cdd.)*
31. X1730A—COMMERCIAL CONTROL	166	51	1·09	2,310
42. X1730K—P.R. 209/43—(NEW B/C PARENT)	146	52	1·10	2,400
32. BAR.X1730L (GENERAL) (7th B/C $\mathbf{B_2B_2}$)	158	50	1·06	2,275
35. P.R. 67/43 }	166	53	1·16	2,535
36. „ 69/43 }	163	53	1·14	2,590
37. „ 71/43 }	152	51	1·18	2,595
38. „ 88/43 } Selection from BAR.X1730L	151	52	1·12	2,615
39. „ 89/43 }	158	52	1·15	2,510
40. „ 90/43 }	165	52	1·15	2,530
41. „ 112/43 }	163	52	1·14	2,285
34. Bulk of P.R.'s—63, 75, 76, 78, 83, 85, 87, 94, 96, 106/43 ...	158	51	1·13	2,395
33. BAR.4/5 (GENERAL) (9th B/C $\mathbf{B_2B_2}$)	153	54	1·29	2,820
48. BAR.5/3 (GENERAL) (9th B/C $R_2^{RS}R_2^{RS}\mathbf{B_2B_2}$)	144	48	1·09	2,335

(*a*) The above are composite samples including all pickings.

(*b*) On yarn strength and staple measurements alone the spinner considered samples 33, 37 and 36 to be the best cottons in that order although all samples were generally weaker, coarser and shorter than those of the N.T.2 series. He further commented that sample 33 (BAR.4/5) stood in a class by itself, with a remarkably good staple diagram and that he had not previously seen any cotton with so little waste at this staple length.

(*c*) Excepting samples 32 and 41, all samples were stronger and most of them finer and longer than the commercial control (No. 31).

(*d*) Sample 34 was a slight improvement on both of the controls No. 31 and 32, and in a varietal test grown at G.R.F. this season (1944/45) seed of this sample gave the third highest seed cotton yield and the highest lint yield when compared with X1730A, N.T.2/39, BAR.X1730L (Gen.), BAR.4/8, BAR.4/5, Selected BAR.N.T.2/41, BAR.N.T.2/41 and Domains Sakel.

(*e*) The selfed seed of samples 35 to 41 was sown as separate 100-plant bulks this season and sample 38 gave the best results. Five selections of P.R.81/44 are being carried forward and the unselfed seed will enter the 1945/46 varietal trial as BAR.X1730L Selection 2. Thus of the 378 random single plants analysed in the 1942/43 season the progenies of only one now remain in the Breeding Plot. The node number of each plant of the 100-plant bulks was recorded this season and ranged from 12 to 21 with progeny means of 14.56 to 16.04. The X1730 series are all later maturing than the Domains Sakel and N.T.2 strains and, for reasons already mentioned, earlier-maturing strains are being sought.

(*f*) At the Barakat Seed Farm this season bulk plots of BAR.X1730L (General) and BAR.4/5 gave seed cotton yields of 1,532 lb. per acre (37·3% G.O.T.) from 45 acres, and 1,663 lb. per acre (33·2% G.O.T.) from 15 acres, respectively. BAR.4/5 (General) has a lower G.O.T. than X1730A or BAR.X1730L but its spinning value is so superior that 600 acres will be bulked up in isolation at the Gash next season to obtain a sufficiently large quantity of lint for a proper commercial valuation. A large area of BAR.X1730L will also be bulked at the Gash next season for the same reason.

(*g*) In addition to the above, later X1730 backcrosses containing the $\mathbf{B_2}$ and/or the $\mathbf{B_3}$ factors for Blackarm-resistance were grown this season and analysed. In general, the backcrosses containing $\mathbf{B_3}$ gave higher seed cotton yields and higher lint indices than those containing $\mathbf{B_2}$. Lint quality was generally similar and many selections are being carried forward for further study.

Variety Trials.

This season two trials were conducted in the Northern Group of the Sudan Plantations Syndicate at Azrag and Abu Wafi, two in the Centre Group at Gezira Research Farm and Barakat, and one in the Southern Group at Hag Abdalla. Conditions were excellent, except for shortage of labour at harvest which resulted in the loss of some cotton on the ground. Seed cotton and lint yield differences were not significant at Abu Wafi and Hag Abdalla and only lint yield differences were significant at the Research Farm. This season, as in the past, conditions under which these trials have been run have not been truly representative of the area in either rotation, preparation, watering

units or other factors, and as these variables may affect varieties differently, results under such conditions are not strictly applicable to the areas concerned. In future seasons such variables will be eliminated and long, narrow subplots will replace the square subplot.

SEED COTTON YIELDS (LB. PER ACRE).

AZRAG ...	N.T.2/39	X1730A	Dom. Sak.	BAR.X1730L	BAR.4/5	BAR.N.T.2/41
lb. per acre	1505·9	1496·9	1424·7	1418·7	1355·6	1274·4
G.O.T. (%)	30·9	32·2	28·8	33·7	30·5	27·6

ABU WAFI ...	BAR.N.T.2/41	X1730A	BAR.4/5	N.T.2/39	BAR.X1730L	Dom. Sak.
lb. per acre	1373·6	1304·5	1286·5	1283·5	1232·4	1226·3
G.O.T. (%)	28·0	32·9	31·2	30·7	33·9	29·0

G.R.F. ...	N.T.2/39	BAR. N.T.2/41 (Sel.)	BAR. X1730L (Sel.)	X1730A	BAR. N.T.2/41	Dom. Sak.	BAR.4/5	BAR.4/8	BAR. X1730L
lb. per acre	2149·2	2095·0	2092·0	2092·0	2025·9	2004·8	1968·8	1965·8	1956·8
G.O.T. (%)	33·4	32·0	35·9	35·2	31·2	30·9	34·0	35·8	36·7

BARAKAT ...	Dom. Sak. (Sel.)	Dom. Sak.	BAR.N.T.2/41	X1730A	BAR.X1730L
lb. per acre	1427·7	1340·6	1292·5	1283·5	1184·3
G.O.T. (%)	31·8	31·7	31·4	35·1	35·8

HAG ABDALLA ...	Dom. Sak.	N.T.2/39	BAR.N.T.2/41	X1730A	BAR.4/5	BAR.X1730L
lb. per acre	2630·1	2527·9	2416·6	2401·6	2329·5	2314·4
G.O.T. (%)	30·1	32·2	29·8	34·6	33·1	35·9

N.B.—Varieties within a bracket do not differ significantly.

The following points are of interest :—

(*a*) The selections, especially selected Domains Sakel, outyielded their parents.
(*b*) Selected Domains Sakel significantly outyielded the commerical Domains Sakel, BAR.N.T.2/41, X1730A and BAR.X1730L, at Barakat.
(*c*) BAR.X1730L was only significantly outyielded by X1730A at Barakat.
(*d*) BAR.4/5 was only significantly outyielded by X1730A at Azrag. Blackarm disease this season was negligible.
(*e*) BAR.X1730L and BAR.4/5 did not differ in yield at any of the sites.
(*f*) BAR.X1730L has a higher G.O.T. than X1730A, and BAR.4/5 is lower than either.

LINT YIELDS (LB. PER ACRE).

AZRAG ...	X1730A	BAR.X1730L	N.T.2/39	Dom. Sak.	BAR.4/5	BAR.N.T.2/41
lb. per acre	482·8	477·1	466·6	413·2	413·2	351·2

ABU WAFI ...	X1730A	BAR.X1730L	BAR.4/5	N.T.2/39	BAR.N.T.2/41	Dom. Sak.
lb. per acre	428·4	414·1	401·7	393·1	384·5	355·9

G.R.F. ...	BAR. X1730L (Sel.)	X1730A	N.T.2/39	X1730L	BAR.4/8	BAR.4/5	BAR. N.T.2/41 (Sel.)	BAR. N.T.2/41	Dom. Sak.
lb. per acre	751·0	735·7	719·5	719·5	703·3	668·9	668·9	632·7	618·3

BARAKAT ...	Dom. Sak. (Sel.)	X1730A	Dom. Sak.	BAR.X1730L	BAR.N.T.2/41
lb. per acre	454·2	450·4	424·6	423·7	405·5

HAG ABDALLA ...	X1730A	BAR.X1730L	N.T.2/39	Dom. Sak.	BAR.4/5	BAR.N.T.2/41
lb. per acre	831·1	829·2	814·9	774·8	771·0	720·4

N.B.—Varieties within a bracket do not differ significantly.

The following points are of interest :—

(*a*) Selected Domains Sakel, with a 3·3% lower G.O.T. than X1730A still outyielded it at Barakat though not significantly. It significantly outyielded Commercial Domains Sakel, BAR.X1730L and BAR.N.T.2/41 at Barakat but Blackarm disease was negligible this season.
(*b*) X1730A significantly outyielded BAR.X1730L only at Barakat, and BAR.4/5 at Azrag and at G.R.F. though here again it must be stressed that Blackarm disease was negligible.
(*c*) Selected BAR.X1730L and selected BAR.N.T.2/41 outyielded their respective parents at G.R.F. though not significantly.
(*d*) BAR.4/8, which carries the B_3 factor for Blackarm-resistance, was not significantly outyielded by any variety at G.R.F.
(*e*) BAR.N.T.2/41 was outstandingly low in lint yield at all sites and was significantly outyielded by Domains Sakel at Azrag.

In conclusion it should be noted that only the Domains Sakel and X1730A seed used in these trials was produced at the Gash—the other seed lots were produced in the Gezira or at Shambat. It is considered that more evidence is needed, particularly from the new strains, before the superiority of any one strain can be stated with certainty.

Miscellaneous.

Massey's Domains Sakel (M.D.S.).

M.D.S. is used only in physiological and agronomical experiments ; it is not grown commercially, but is the variety on which the growth observations from which crop yields are predicted are made seasonally. Purification of the strain was begun in the 1940/41 season(5) and concluded last season. This season the selected material was compared with the parent stock in a replicated experiment and, although more uniform in appearance, did not differ from the parent in any of the major characters. The following are means from eight subplots for the selection and its parent stock :—

Character.	*Selection.*	*Parent Stock.*
Weight of seed cotton per boll (100 bolls)	3·01 gm.	3·00 gm.
Weight of lint per boll	1·00 gm.	0·99 gm.
No. of seeds per boll	15·51 seeds	15·39 seeds
Weight of 100 seeds	12·94 gm.	13·08 gm.
Lint index	6·40 gm.	6·43 gm.
Ginning out-turn	33·15%	32·99%
Hair weight	134	129
Mean Length	1·19 ins.	1·10 ins.
Lea Product (60's cdd.)	2,885	2,620

Spinning tests on the 1943/44 season's material showed the selection to be very slightly longer and of the same fineness, but stronger than the parental control. This experiment is now concluded.

Leaf Curl Disease Resistance Work.

A full description of this work and the technique employed has already been published.(6) It has been proved that all the X1730 and N.T.2 series, including those with Blackarm-resistance added, and Lecrem, are very highly resistant to leaf curl disease under Gezira conditions and that the N.T.2 series is also very highly resistant at Shambat.

It has also been shown that by selection highly resistant strains can be extracted from Massey's Domains Sakel and Commercial Domains Sakel, even though these varieties were formerly considered fully susceptible. At the Research Farm this season, only selections from these two varieties were grown, using the same type of layout and technique as formerly. Unfortunately leaf curl incidence was low, due probably to the ban on growing *Malvaviscus* sp. in the Farm gardens, which was the major source of infection in the past. Because of the low incidence it was necessary to wait until after the plants were cut back to obtain a large enough spread of this disease to allow of the data being analysed. Twenty-one Domains Sakel and 8 Massey's Domains Sakel selections were tested against unselected Commercial Domains Sakel and known susceptible " spreader " material. Strain differences were highly significant, but again because of the low incidence of leaf curl, standard errors were high. However, some

very excellent material has been selected, particularly in the Massey's Domains Sakel where the highest strain infection was only 16%, and one strain, although surrounded in 10 plots by the disease, remained free of it even after it had been cut back. Three of the Domains Sakel selections had mean infections of only 2% and 4% as compared with the control at 20%. It is considered that enough evidence is now available as to the resistance of this material to make duplicate tests of it worth while at Shambat and at the Gezira Research Farm in the coming season. X1730A, which is highly resistant in the Gezira, shows high susceptibility at Shambat, where the incidence and severity of leaf curl disease is always greater, for reasons not yet explained.

Fuzzed Seeds in Domains Sakel, BAR.N.T.2. and X1730A.

Fuzzed seeds of the above varieties were found by the Manager, Port Sudan Ginnery, during the ginning of Gash-grown cottons and sent in for investigation in 1943 and 1944. Plants from the Domains Sakel samples were indistinguishable from typical Domains Sakel in every character and gave only normal seeds. The fuzz in this sample, although completely covering the seed, was short and like that seen frequently in Sea Island cottons where it occurs in the ratio of approximately 3 fuzzed to 97 tufted. It appears to be physiological rather than genetic.

The BAR.N.T.2 fuzzed seeds behaved differently. Of the eight plants raised six were normal and probably identical with the Domains Sakel sample described above, and the other two produced a mixture of fully-fuzzed and normal. The fuzz in these two plants was long and thickly covered the whole seed. This type of fuzz is similar to the fuzzy mutation from tufted which occurs in the *barbadense* group and was recorded by Harland in Montserrat Sea Island in 1916 and by Evelyn in St. Vincent Superfine Sea Island (V.135) in 1936.(7)

Five plants were raised from the X1730A sample of which three produced only fully-fuzzed seeds and the other two only normal seeds. In all other characters the plants were typically X1730A. The investigation is being continued, but it is thought that the fuzz in both the N.T.2 and X1730A samples arose by mutation from tufted in the manner already recorded in Sea Island cottons.

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(4) „ „ „ „ „ „ „ 1943/44, p. 66.
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Breeding and Testing of Dura (*Sorghum* Spp.)

BY

S. H. EVELYN.

The Dura Type Collection.

The collection now numbers 500 specimens and the most important of their genetic and commercial characters are being recorded. This season, 351 types were grown for this purpose and also observed for midge and bird damage. Work on Common Smut, in conjunction with the Plant Pathology Section, was temporarily suspended. To date, 330 types have been tested for resistance to *Sphacelotheca sorghi*—form 3, and a number of these are now known to be immune or resistant. A paper on the home of origin of *Sorghum* is now in preparation.

Dura Hybridization.

It is considered that the vast number of types existing in the Sudan makes available a sufficiently wide range of genetically variable material for straightforward selection to be effective without recourse to hybridization, except perhaps for the transference of disease and pest resistance. For this reason hybridization work has been temporarily suspended.

Variety Trials.

Northern Province.

Trials this season of Dwarf White Milo at Aliab, Ghaba and Zeidab, demonstrated the bird-resistance of this variety. Past experiments in this province have always failed for one reason or another, but mainly because of bird and stemborer damage. It is recommended that in the coming season selected cultivators should compare Dwarf White Milo against their local types in several areas. The staff of the Plant Breeding Section is inadequate to permit of the carrying out of replicated trials unless these can be sown, supervised and reaped by the Inspector of Agriculture concerned.

Kassala Province.

The trial this year, under flood irrigation in the Gash Delta, has proved without doubt that Aklamoi White is superior in every respect to all the likely varieties it has been tested against. This supports past results. Unfortunately commercial seed of this variety is a mixture of 67·6% Shabet, 17·8% Red Aklamoi, and only 14·5% White Aklamoi ; it is therefore recommended that pure seed of White Aklamoi be selected and bulked up under the supervision of the Inspector of Agriculture with the object of ultimately replacing all other planting seed in this area.

At Tokar, White Aklamoi also proved vastly superior to the local Baham and it has been decided to replace Baham with selected White Aklamoi. Abu Kudur gave the highest yield in the tests and is considered of high potential value in the Upper Delta. Confirmatory tests will be run in 1945.

At Gedaref, in the area set aside for mechanical reaping trials, Dwarf White Milo, in the first year of testing under rain on a very large area, showed great possibilities and a large quantity of seed has been selected for further trial in 1945. Replicated trials are also being run.

Ali Gidder Station, Tessenei, Eritrea. (Adjoining Gash Delta.)

In the flood irrigated trial White Aklomoi has again been superior to all the likely varieties it was tested against, and is being bulked up in a pure state to replace all other local irrigated types.

In the rain areas all the introduced varieties were superior to the local rain types—Wad Farag, Wad Akar and Bahana. The introduced varieties were Feterita Dwarf Managil, Fet. Dwarf 6603, Fet. 1931, Dwarf White Milo and Dwarf Hegari. Of these, Dwarf Managil and Dwarf White Milo gave the best results and are being bulked up for distribution.

Blue Nile Province (Irrigated).

At the Gezira Research Farm, Dwarf White Milo, although very impure, again outyielded sixteen other types, composed mainly of the Feterita varieties that were said to have beaten it in the Sudan Plantations Syndicate Block Demonstration trials in 1943. At the Research Farm its impurity has increased year after year, as it is within easy outcrossing distance of at least 350 other types. It is strongly recommended that this excellent variety be bulked up and distributed throughout the whole of the Irrigated Gezira. The first big bulking will be done at Abdel Rahman Block in 1945.

The "Scattered Block" trials at the White Nile Alternative Livelihood Schemes at Abdel Magid, Fatisa, Hashaba, Dueim and Um Gerr, in which Dwarf White Milo was tested against the local Feteritas, Dwarf Yellow Milo and Dwarf Hegari, failed to give a significant result, mainly because of locust damage and the impurity of Dwarf White Milo. Main crop Dwarf White Milo sown with purer seed from Abdel Magid gave superior results. These trials are being continued but pure Dwarf White Milo is strongly recommended for these areas.

Blue Nile Province (Rain).

"Selected Block" trials of Dwarf White Milo and other likely varieties were conducted at the Research Farm, and at Gondal, Managil, Rufaa, Shaburga, Tundub and Sennar. Many of these failed as a result of locust and bird damage and poor rains, but valuable results were obtained at the Research Farm and at Managil. Treating the sites as blocks in a single random block experiment, varietal significance was not obtained, although Dwarf Hagari and Dwarf White Milo gave the highest mean grain yields. In gassab yield, Dwarf White Milo was only outyielded by Feterita Maatuk, though not significantly. The Milo seed was very impure and it is considered that had purer seed been used there is every likelihood that Dwarf White Milo would have significantly outyielded the other varieties. These tests will be repeated.

Upper Nile Province.

A first trial of Dwarf White Milo, Dwarf Yellow Milo and Dwarf Hegari was carried out in unreplicated demonstration plots at Kodok, as the local varieties are badly mixed and yields have, for some years, been very low. Germination was very poor, necessitating a heavy re-sow, nevertheless the Milos yielded at the rate of 250 lb. of grain per acre, which, under the circumstances, is very promising. These varieties will be tested against local varieties in 1945.

Kordofan Province.

Um Alwan, a new area nine miles north of Dilling and more representative of the commercial dura of this part of the Nuba Mountains, replaced the Dilling site this season. Twenty varieties were tested in a six replicated random block layout and varietal differences were of high significance. These varieties will be re-tested in 1945.

At Kadugli, " Early," " Medium " and " Late " varieties were tested and gave the following results :—

Of the six best " Earlies," chosen after 3 years of trials, Taha's 85 significantly outyielded the others and should replace all other " Earlies " in this area, as it has now given the best mean yield throughout the period 1941 to 1944.

Of the eight best " Mediums," again chosen after 3 years' trials, Karinaka, Birgalli Ahmar and Maga Ahmar supported the results of past years, and as their mean yields for the period 1941–1944 are the highest for this group, it is recommended that they, or any one of them, should replace all other " Medium " varieties in this area.

Of the four best " Lates " chosen after 3 years' trials, Kulum significantly outyielded the others, as it did in 1943, and remains top of the list for mean yield over the period 1941–1944. Kurgi, the alleged locust-resistant variety, was, as expected, significantly outyielded by all others. Because of Kurgi's popularity for beer-making quite large areas are grown every year, but being very late maturing it gives a yield only about once in five years when rains are heavy and continue late. Kulum, this season, significantly outyielded Kurgi by 164 per cent. It is strongly recommended that Kulum should be bulked up in a pure state and distributed to replace all other " Late " varieties in this area.

At Talodi, where trials have been conducted since 1940, the best six of each of the " Earlies," " Mediums " and " Lates " were tested in replicated random block layouts.

Of the " Earlies," Birgalli Ahmar, Maga Abiad and Wad El Gussair gave the highest yields, as they did in 1943. Yields were in general, very poor, and although these varieties can be recommended to replace all other " Earlies," a confirmatory test will be run in 1945.

Of the " Mediums," Jangi significantly outyielded the others and has thus maintained its position at the top of the varietal list in mean yield for the period 1940–1944. This variety should replace all other " Mediums " in this area.

Of the " Lates," Galb El Jackus and Kulum gave the highest yields, as they did in 1943, although in that year Kulum outyielded Galb El Jackus. Makoi, the main " Late " variety grown in this area, was, as expected, significantly outyielded by all the others and by Galb El Jackus and Kulum by 99% and 81% respectively. Makoi, has in five years of trial given only one yield of 1,000 rotls of grain. It is strongly recommended that only Galb El Jackus and Kulum be grown as " Late " varieties in the future.

Equatoria Province.

Unfortunately the plan of the Varietal–Sowing Date trial was misunderstood and results were accordingly obscured. However, the Inspector of Agriculture, Kagelu, has had most promising results from recent introductions from Uganda and from two local varieties—Morua White and Morua Black. As he is on the spot, it has been decided to leave future trials in his hands and only provide the necessary layouts from this office.

SHAMBAT STATION

BY

R. L. KNIGHT.

Introduction.

The basic work of this Station is the direct application of genetics to plant breeding problems. No cotton selection is carried out at Shambat (except such specialized selection as is required in carrying out programmes of hybridization) so that this Station deals primarily with material which has been selected and bred either in the Gezira, by Mr. Evelyn, or in Kordofan by Mr. Anson. The main lines of work consist in the improvement of such selected varieties by transferring specific genes to them from other varieties or species.

Meteorology.

The season was somewhat drier than usual with a rainfall of just under 4½ inches, but this was well distributed throughout July, August and September, resulting in satisfactory conditions for obtaining an excellent " take " of Blackarm on the in-season crop (sown mainly in July). Temperatures were above average. In the period from 1st May, 1944, to 30th April, 1945, inclusive, there were 198 days when the shade temperature registered 100°F. or over, 45 days with 110°F. or more, and 6 days with a shade temperature of 115°F. or over. These figures compare with 228, 39 and 4 days, respectively, for the previous season. High temperatures again affected the out-of-season crop severely from early April onwards and yields were greatly reduced.

Genetics and Breeding.

Production of Blackarm-resistant "Egyptian" Varieties.

1. *Blackarm-resistant Domains Sakel.*—Using Mr. Evelyn's latest Domains Sakel selections as the recurrent parent, the transference (from Blackarm-resistant N.T.2) of the resistance genes, $\mathbf{B_1}$, $\mathbf{B_2}$ and $\mathbf{B_3}$ was carried to the third backcross stage and seed of fourth backcross type has been produced for sowing in 1945–46.

2. *Blackarm-resistant N.T.2.*—640 acres of Blackarm-resistant N.T.2/41 (containing $\mathbf{B_2}$) were grown in the Gash and yielded an average of 2·91 kantars (908 lb.) per acre as compared with 2·97 (927 lb.) for the X1730A areas and 2·10 (655 lb.) for the Sakel. In the Gezira, 6,498 acres of this variety were grown and gave an average yield of 5·45 kantars (1,700 lb.) per acre. This area was made up of three sites: 1,459 acres at Wad Naaman (Southern Gezira) which yielded 4·75 kantars (1,482 lb.) per acre, 3,329 acres at Wad el Bur (Central Gezira) which averaged 6·88 kantars (2,147 lb.) per acre, and 1,710 acres at Laota which gave 3·23 kantars (1,008 lb.) per acre.

3. *Blackarm-resistant X1730.*—Seventh backcross material of X1730 type, containing the American Upland resistance gene $\mathbf{B_2}$, was again on test in five variety trials in the Gezira this season under the number BAR.1730L. In four of these tests there was no significant difference in lint yield between X1730A and BAR.1730L; in the fifth test (at Barakat), however, the former gave 28 lb. more lint per acre and this difference was significant. A 45-acre propagation plot of BAR1730L in the Gezira yielded 4·91 kantars (1,532 lb.) per acre.

Ninth backcross material of X1730 type, containing $\mathbf{B_2}$, was also on test at four of the five sites in the Gezira, under the strain number BAR.4/5. In two of these tests its lint yield differed significantly from neither X1730A nor BAR.1730L but at one site (Azrag in the Northern Gezira) it was significantly outyielded by both and at the Gezira Research Farm it was beaten, significantly, by X1730A. Since the seed of BAR.4/5 used in sowing these tests was all obtained from an out-of-season plot sown at Aliab, Northern Province, in late February, 1945, no great reliance should be placed on these results. A 15-acre propagation area of BAR.4/5 in the Gezira yielded 5·33 kantars (1,663 lb.) per acre.

Spinning tests for this season are not yet to hand, but the results of the previous season show BAR.1730L to be fully the equal of X1730A and BAR.4/5 to be rather better. BAR.4/5 was particularly favourably reported on by the Spinning Technologist at Giza.

At Shambat a small propagation plot was grown of X1730 homozygous for both $\mathbf{B_2}$ and $\mathbf{B_3}$, under the strain number BAR.4/11. This variety, the equivalent of eighth backcross material, is highly resistant. Enough seed was produced to include BAR.4/11 in the Gezira variety tests next season and to have a small propagation plot

at Medani. An attempt to speed its propagation by growing 2 acres out-of-season near Sennar failed because the out-of-season plot suffered from the effect of high April–May temperatures and from an extremely severe attack of bollworm.

In the breeding plots the transference of $\mathbf{B_2}$ amd $\mathbf{B_3}$ was taken a backcross further as an insurance against any unforeseen faults in BAR.4/11. Enough seed of this ninth backcross material was produced to sow a small propagation plot at Shambat next season.

4. *Transference of Blackarm immunity from* G. sanguineum* *(n=13) to Egyptian (n=26) types.*—Fifth backcross progenies were raised in 1944–45 winter and sixth backcross seed was produced for sowing next season. In addition crosses were made between types containing the transferred *Sanguineum* factor and Sakel varieties homozygous for $\mathbf{B_1}$, $\mathbf{B_2}$ and $\mathbf{B_3}$ in order to study the relationship of the Asiatic factor to the three known New World genes.

5. *Flagging Blackarm-resistant X1730 with the* arboreum *gene for red flowers and leaves.*—The *arboreum* gene for red flowers and leaves has been transferred to ninth backcross X1730 (carrying $\mathbf{B_2}$) and the only spinning test so far obtained on this material gives it a similar lea product (60's) to X1730A and a lower hair weight.

It is not intended to bulk this strain for commercial purposes; the transference of arboreum-red to X1730 carrying both $\mathbf{B_2}$ and $\mathbf{B_3}$ is being carried on so that when the ultimate highly-resistant product is released commercially, a similar type with red flowers and leaves will be available for full-scale testing.

Production of Blackarm-resistant Strains of American Upland for the Southern Sudan.

1. *Blackarm-resistant Uganda S.P.84R.*—This season the first step was taken in the integration of a variety of S.P.84R homozygous for $\mathbf{B_2}$ and $\mathbf{B_3}$. A small plot of S.P.84R homozygous for $\mathbf{B_3}$ (without $\mathbf{B_2}$) was grown under the strain number BAR.7/5. This type was synthesized by crossing *G. punctatum* carrying $\mathbf{B_3}$, five times on to SUS.7/2 the susceptible element of S.P.84R. During 1944–45 winter crosses were made between this BAR.7/5 and BAR.7/1, and from these will be bred a strain of Uganda S.P.84R of $\mathbf{B_2B_2B_3B_3}$ composition.

As a safeguard, seed for sowing a small plot of BAR.7/6 was produced. This is S.P.84R carrying $\mathbf{B_3}$ without $\mathbf{B_2}$ but of fifth backcross composition. The F_1 of BAR.7/5 × BAR.7/1 will be backcrossed to this BAR.7/6 type next season.

2. *Blackarm-resistant Deltapine.*—In the transference of $\mathbf{B_2}$ from N.T.61/38 to Deltapine, second backcross material homozygous for $\mathbf{B_2}$ was on test at Kadugli under the strain number BAR.10/1. At

* *G. arboreum* L. race *bengalense* (Silow).

Shambat small propagation plots of third and fourth backcross type were grown. This concludes the Blackarm-resistance programme for Deltapine.

3. *511D* (*from Uganda S.G.85*).—This type already carries $\mathbf{B_2}$. Enough seed was obtained from F_2 progenies of fourth backcross composition to grow a small propagation plot next season homozygous for both the *punctatum* gene $\mathbf{B_3}$ and the American Upland gene $\mathbf{B_2}$. This concludes the Blackarm-resistance breeding programme in 511D.

4. *Blackarm-resistant X.A.129* (*from Pump Scheme Strain*).—X.A.129 is fully susceptible to Blackarm. $\mathbf{B_2}$ has been transferred from N.T.61/38, and homozygous material of second backcross origin was on test in the south this season under the number BAR.11/1. At Shambat a small propagation area of BAR.11/1 was grown with a nucleus of third backcross origin, and during 1944–45 winter fourth backcross $\mathbf{B_2B_2}$ X.A.129 was bulked as BAR.11/5.

Meanwhile as the first step in adding $\mathbf{B_3}$, the *punctatum* gene, $\mathbf{B_3B_3}$ Sakel was crossed with X.A.129 four times and the product of this was crossed with BAR.11/5.

5. *Blackarm-resistant Uganda B.P.52*.—Like so many of the better quality American Uplands, this type is fully susceptible to Blackarm. The transference of $\mathbf{B_2}$ from N.T.61/38 was taken to the fifth (and final) backcross stage during 1944–45 winter and, in addition, seed was raised for sowing bulk propagation plots of third backcross material at Shambat next season. From the third backcross progenies both the resistant and the susceptible elements will be separately bulked and tested against each other.

The transference of $\mathbf{B_3}$ to B.P.52 was taken to the second backcross stage.

6. *Blackarm-resistant N.T.96/42*.—N.T.96/42 is heterogeneous for resistance. In co-operation with Mr. Anson this variety was "sorted" for resistance and bulk self-bred seed homozygous for $\mathbf{B_2}$ was produced for propagation in Northern Province next season.

Pink Bollworm (Platyedra gossypiella) *Resistance.*

1. *Gossypium thurberi* Crosses.—As stated in previous reports, *thurberi* appears, at Shambat, to be immune to Pink bollworm. Again F_1 plants of *thurberi* ($n=13$) × Sakel ($n=26$) were raised and again backcrossing was attempted without success, neither did treatment with colchicine achieve any greater success than last season. More F_1 seeds have been produced and these will be soaked in 0·05% colchicine for 48 hours before sowing.

2. *G. armourianum* Crosses.—*Armourianum* itself shows very marked bollworm-resistance at Shambat. The hexaploid *G.* "*armadense*" obtained from the cross *armourianum* × Sakel also showed complete freedom from bollworm. It seems probable that this resistance is connected with the copious supply of essential oils

and/or resins found in the oil glands dotted over the plant and especially in those located on the bolls. This essential oil is strong-smelling and is not unlike citronella oil. It is hoped to transfer this character to Sakel, and, with this object, crosses were made between *G. " armadense "* and Sakel. These will be sown next season.

Jassid-resistance.

Just as Blackarm-resistance genes have been taken from different cotton species and added together to give something approaching immunity, so also, with hairiness, it should be possible to add together several genes to give a type almost immune to jassids. Macdonald, Ruston and King(1) stress the importance of both length and density of hairs in combating jassids but it is unlikely that a satisfactory combination of length and density would be dependent on a single gene. Accordingly transference of hairiness is being undertaken from a number of varieties and species to Sakel. Only two of these transferences have gone beyond the preliminary stage : the gene **H** from Tanguis has been added to Blackarm-resistant X1730 and is being added to Domains Sakel, and a single major hairiness gene from Carpulla (a *barbadense* type) is being transferred to Blackarm-resistant X1730. Other sources of hairiness include Marie-Galante (variety St. Ignatius), American (varieties Kapas Purao, Ferguson and M.U.8b), *G. tomentosum* (for density), *G. anomalum* (for length), and *G. arboreum.*

The samples for spinning tests from last season's plots could not be sent off in time for it to be possible to receive the results in time for this report, so that there is no information as yet as to the effect, if any, of the Tanguis gene **H** on lint characters.

On the American side Uganda S.P.84 homozygous for $\mathbf{B_2}$ was again used as the backcross parent in the transference of the Tanguis hairiness gene **H** to American Upland. A small propagation plot was sown with fourth backcross material of **HH** type, but unfortunately locusts ate this off at ground level shortly after it had germinated and there was no seed for re-sowing. Seed from later backcrosses should be available for propagation next season.

The transference of the *tomentosum* hairiness gene to X.A.129 from a hybrid received from Mr. Hutchinson, in Trinidad, was carried to the first backcross stage and second backcross seed was produced for sowing next season.

Ginning Outturn Investigation.

As mentioned in previous reports, Deltapine has a ginning outturn of approximately 40% but has lint of poor spinning quality ; X.A.129 has a ginning outturn of about 30%, has lint of good spinning quality, and is well-suited to conditions in Equatoria. This line of investigation was started with the object of transferring some, if not all, of the high G.O.T. of Deltapine to X.A.129 if this can be done without deleteriously affecting lint quality.

(1) E.C.G.C. Prog. Rept. Expt. Stns., 1943/44.

In the F_2 of the first backcross to X.A.129 75 plants were selected this season for high G.O.T. coupled with quality of about X.A.129 standard. In the second backcross progenies four plants were selected as showing the desired combination of quality and ginning outturn.

Cotton Type Collection from Trinidad.

299 individual types of cotton were sown at Shambat, but the seed was received rather late in the season. Unfortunately its germination coincided with the beginning of a series of attacks by swarms of flying locusts from which the type collection suffered severely. 240 types were eventually established.

Types not established this season will be grown again next season, together with any additional varieties from Trinidad.

Blackarm-resistance Survey of Wild Cottons.

A preliminary list was given in my 1942–43 report (p. 72). The following additional types have now been examined :—

G. anomalum : almost immune.

G. aridum : resistant.

In the same report it was recorded that *Thespesia populnea*, though resistant, can be readily infected with Blackarm. *Thespesia Garckeana* has now been infected on several occasions, but *Garckeana* shows greater resistance than *populnea*.

Crops Other than Cotton.

1. Bamia (*Hibiscus esculentus*).

Routine propagation of pure seed stocks was carried out and some 1,900 lb. of seed was sold to seed merchants and cultivators.

2. *Ocimum kilimandscharicum.*

One of the two progeny rows carried on from last season continued to show a markedly increased camphor content. Seed of this has now been stored pending a clarification of the future of natural camphor *vis-à-vis* the synthetic product.

Diseases and Pests.

Blackarm (*Bact. malvacearum*) was, as usual, general at Shambat.

Leaf curl was sporadic and not severe except in isolated cases.

Pink bollworm (*Platyedra gossypiella*) though serious, was not quite as severe as in previous seasons.

Locusts caused considerable damage, including the total destruction of two propagation plots.

Summary and Conclusions.

In previous years it has been shown that the two American Upland genes $\mathbf{B}_1$ and $\mathbf{B}_2$ governing resistance to Blackarm can be transferred to "Egyptian" varieties without affecting lint quality and spinning value. It will be seen from the spinning test data given in Mr. Evelyn's report that evidence now shows that the *punctatum* gene $\mathbf{B}_3$ can similarly be transferred without adversely affecting lint in any way. These facts show that control of Blackarm disease can safely be undertaken by plant breeders with certainty of success. But even more important than this, yield trials and spinning tests over several seasons show that it is possible to transfer genes from species to species without disturbing genetic balance, yield or spinning value.

On the "Egyptian" side the transference of Blackarm-resistance to Domains Sakel continues at the rate of two backcrosses a year. Over 7,000 acres of Blackarm-resistant N.T.2 were grown commercially, whilst resistant X1730 reached the 45-acre stage for 7th backcross material with a 15-acre nucleus of 9th backcross origin. At Shambat the first wave of X1730 carrying both $\mathbf{B}_2$ and $\mathbf{B}_3$ was synthesized.

On the "American" side a number of varieties have now either been sorted for Blackarm-resistance or have had resistance transferred to them and variety tests are beginning to prove the value of this work.

In the hope of obtaining Sakels resistant to Pink bollworm, work has started with the object of transferring the strong-smelling character of the essential oil of *G. armourianum*.

An experiment aimed at increasing the G.O.T. of X.A.129 by hybridization was continued.

PROGRAMME OF EXPERIMENTS 1945-1946.

The lines of work shown in this report will be continued and special attention will be paid to the possibility of obtaining bollworm-resistance from *armourianum* and *thurberi* crosses. Also work on the transference of various types of hairiness from a wide range of cottons to Sakel will be stepped up.

KADUGLI STATION

BY

R. R. ANSON.

Introduction.

The Station remained under the supervision of a Senior Technical Assistant (Mohd. Eff. Taha el Faki). It was visited from time to time by Mr. Anson who directed the work from Wad Medani but this

arrangement, because of the great distance between Wad Medani and Kadugli, was not satisfactory. In the coming season Mr. Rose, a member of the Corporation's staff, will be transferred from their Barberton Station and will take up the duties of Plant Breeder in charge of Kadugli Station.

In Kordofan there was a further substantial reduction in the acreage under cotton and the commercial crop sown amounted to little more than one-tenth of the pre-war area. Demand for seed naturally exceeded supply but could not be fully met because the total seed issue had to be kept down to 2,000 ardebs (one ardeb = 205 lb. approx.) and when this amount had been reached all seed issues were closed down.

The total area planted was estimated at between nine and ten thousand acres. Government policy has been to keep the industry ticking over, as it were, until such time as pre-war conditions again prevail, when it is hoped that the necessary machinery will be put into action and the industry brought back to the pre-war production.

Inherent Agricultural Circumstances.

The present policy of restricting seed issues has limited the number of growers and thus created ideal conditions for isolating small areas of promising strains. Full advantage has been taken of this in establishing seed reserves. These pure seed reserves have been collected with an object of accumulating a number of different varieties for testing throughout the country. Such tests will be made with a view to discovering one strain suitable to all conditions. With these small seed reserves available, should any one strain prove to be significantly superior to all others it could be bulked up fairly rapidly. The ideal would be to grow a single strain of American cotton throughout all the rain areas of the Sudan. Not only would this eliminate risk of seed admixture but it would also provide a crop of adequate size to supply brokers and spinners with sufficient quantity of all grades they might require from within the Sudan American long staple class.

With the present drive for increased grain production the Government has raised the guaranteed price for sorghum, and is prepared to purchase as much as cultivators can produce. Sorghum has thus become a cash crop which under prevailing prices compares very favourably with cotton. The cultivator has not been slow to realise this and, because sorghum is more easily grown and harvested, a switch over to it from cotton is likely to be complete until such time as there is a glut in the market ; even then, it is likely that cultivators will require considerable persuasion before we shall see the Nuba Mountain's cotton crop back again to pre-war proportions.

Meteorology.

Growing conditions were favourable and yields from commercial areas slightly above average ; rains commenced early in May and continued fairly consistently until mid-October.

Rainfall at Kadugli : Monthly Totals in mms.

	Feb.	*March.*	*April.*	*May.*	*June.*	*July.*	*Aug.*	*Sept.*	*Oct.*	*Nov.*	*Total.*
1944/45	0·0	15·0	1·4	75·7	149·5	160·0	124·1	128·8	52·8	0·0	707·3
Average, 1910/37 ...	2·0	1·0	16·0	72·0	129·0	150·0	147·0	138·0	81·0	5·0	741·0

The total rainfall for the two previous seasons, 1942/43 and 1943/44 amounted to 671·0 mm. and 663·0 mm. respectively. Planting commenced on 19th June, 1944, and first pickings were made on 23rd October, 1944.

Breeding and Testing.

The number of strains grown in the breeding plots was reduced to a minimum and work concentrated on improvement of early-maturers with low node numbers, high ginning outturn and good quality. One family, a selection from N.T.205/42 (an S.P.20 derivative), shows promise and again gave a high ginning outturn (37·0%) and a good halo length (33·8 mm.). This selection is early, resistant to Blackarm and jassid and the boll holds the seed cotton well. Ample self-bred seed has been obtained from it to plant thirteen progeny rows from selected plants. These will be grown in the 1945/46 season and belted with self-bred seed from the remaining unselected plants. Other families consisted of :—(1) *Selections made from Uganda B.181.*—These families were considerably later maturers, susceptible to Blackarm, but fairly resistant to jassid. The lint was long, averaging 34·4 mm., but somewhat weak and the G.O.T. averaged 29·7%. Ten selections will be grown in progeny rows in season 1945/46. (2) *Uganda B.P.52.*—A rather late maturer, susceptible to Blackarm, but not to jassid. Long lint of excellent quality (35 mm.) and an average ginning outturn of 30%. Four selections have been made and will be planted out in the coming season.

Random Progeny Tests.—These were designed to supply data on the best yielding strains and to study the effect of Blackarm-resistance on yield. An excellent stand was obtained. All plants were sprayed with Blackarm in suspension and this operation was repeated on three successive days in order to insure a uniform infection. Ten replications were made of five plants from each strain tested. The following gives the yield of seed cotton in gms. :—

Deltapine Rest. BAR.10/1	*N.T. 206/41*	*N.T. 205/43 Rest.*	*N.T. 96/40*	*P.S. Stn. Control*	*SP.84 Rest. BAR.7/1*	*N.T. 205/41 Het.*	*SP.84 SR. BAR.7/3*	*Deltapine SUS.*	*SP.84 SUS.*
289·8	257·6	256·7	222·8	219·6	217·2	209·1	198·4	198·1	176·2

Strains within the bracket do not show significant differences between each other. The addition of the Blackarm-resistance factor $\mathbf{B_2}$ has significantly raised the seed cotton yields of most strains when Blackarm is present.

Varietal Tests.—The following varieties were tested at Kadugli :— (1) Deltapine, 32 mm. (selected from an importation from Delta and Pine Land Co., U.S.A.) ; (2) N.T.205/41 selected from Uganda S.P.20 for earliness (heterogeneous for $\mathbf{B}_2$) ; (3) S.P.84 Rest. (BAR.7/1, a bulking of selected plants made at Shambat from S.P.84 which is heterogeneous for $\mathbf{B}_2$) ; (4) Pump Scheme Strain (the present commercial crop used as a control) ; (5) N.T.206/41 (a long-stapled selection from Uganda S.P.84) ; (6) N.T.96/40 (a selection made from 57× Over-the-Top).

There were five replications of each strain. Sub-plots measured 48×6 metres and were long and narrow. With the exception of Deltapine which in weight of lint significantly out-yielded all other varieties, there were no significant differences. Well-spaced and continuous rains promoted a long growing season and thus provided ideal conditions for the later maturing strains. This to some extent may have brought about a levelling effect. Variation between sub-plots of the same variety was high, and, in an attempt to lessen this variation, it has been decided to double the number of replicates in future.

At Talodi, lint yields were more consistent and strains occupied much the same positions as they held in the season 1943/44. Deltapine (32 mm.) and S.P.84 Rest significantly out-yielded all other strains but did not differ significantly themselves.

Propagation Areas.

N.T.205 Strains.—N.T.205/41. (Bulked progenies from selections made within Uganda S.P.20, a U.4/4/2 derivative, heterogeneous for Blackarm-resistance and highly-resistant to jassid.) Twenty-five acres of this strain were sown by one cultivator at Ganaya which is situated about twelve miles north of Kadugli. The yield from this averaged 650 lb. per acre and gave an average ginning outturn of 33·9%. Quite a satisfactory performance for native rain-grown cotton.

N.T.205/43 Rest. (An early strain composed of bulkings from several plants containing the Blackarm-resistant element $\mathbf{B}_2$. These were separated from N.T.205/41 at Shambat.) Twenty acres sown under irrigation in isolation at Shendi yielded 23,850 lb. of seed cotton. Some of the seed from this will be used for testing, the remainder will be bulked in isolation at Miri, in the Nuba Mountains.

S.P.84 Rest. (BAR.7/1, another early strain from Uganda S.P.84R rendered homozygous for $\mathbf{B}_2$.) It was grown on a small isolated plot of $1\frac{5}{8}$ acres and produced 2,277 lb. of seed cotton=1,401 lb. per acre. The ginning outturn for all grades averaged 33·5%. This strain is intended for Equatoria to replace 511D the present commercial variety. It has a ginning outturn 3·5% higher, significantly out-yields 511D and spins almost as well. Next season 80 acres will be planted in Equatoria at Meridi and a further 20 acres at Dam Gamad in the Talodi district.

N.T.58 Strains.—N.T. 58/39 (originated from selections made from an outcross found in 513 (Punjab Early) chosen for earliness and quality of lint.) This selection has been carried forward to a further increase area of 1,500 acres. This area comprised the combined holdings of the Fellata cultivators at Berdab (an isolated settlement of Westerners about 14 miles North-west of Kadugli). Yields varied from 200 to 1,200 lb. of seed cotton per acre, according to sowing date and the amount of attention given after planting. The average yield from the area amounted to 390 lb. per acre.

Small nucleus plots, N.T.58/42 from N.T.58/39 (1·65 acres) and N.T.58/43 from N.T.58/42 (·35 acre) planted on the Kadugli Main Farm yielded 1,230 lb. and 1,570 lb. of seed cotton per acre respectively.

N.T.96/40. (A selection made from an importation from Nyasaland of hybrid material from 57×Over-the-Top.) This strain was selected for earliness and yield ; it is heterogeneous for $\mathbf{B}_2$. Sixteen acres sown at Talodi farm gave an average yield of 600 lb. of seed cotton per acre and an average ginning outturn of 32·1%.

N.T.209/41. (A selection made from Harland's (U.4×Cambodia) ×U.4, for quality and long staple.) This was grown on a three-acre plot at Talodi and yielded 580 lb. of seed cotton per acre and gave an average ginning outturn of 29·8%.

N.T.206/41. (Selected for long lint from S.P.84.) It was severely attacked by flea beetle in the early stage of its growth and yielded practically nothing.

Pests and Diseases.

Flea beetle (*Podagrica punticollis*) attack was severe in August and did considerable damage. Leaf roller (*Sylepta derogata*) showed up in September ; it was kept in check by hand picking.

Bollworm and stainer infestation were not abnormal.

Blackarm appeared in late September, too late to do much damage.

Conclusions.

Varietal differences were slight and lint yields did not differ significantly except in the case of Deltapine. Differences between early and later maturers may have been reduced by well spaced rains, but the error residual was high. With a view to rectifying this high error, replications will in future be doubled.

High prices plus unlimited demand have put sorghum into line with other cash crops and made it a keen competitor with rain-grown cotton.

The introduction of the factor $\mathbf{B}_2$ for Blackarm-resistance significantly increased yields when Blackarm was present.

APPENDIX.

Key to Symbols Used in This Report.

Genes.

B_1 A dominant, weak Blackarm-resistance factor derived from American Upland (Uganda B.31).

B_2 A dominant, strong Blackarm-resistance factor from American Upland.

B_3 A strong, partially dominant Blackarm-resistance factor from *G. punctatum*.

H A hairiness factor from Tanguis.

R_2^{RS} A factor governing reddish flowers and leaves, from *G. arboreum*.

Varieties.

Domains Sakel. The standard cotton in the northern half of the Gezira. Seed stocks of this type were originally imported from Egypt.

X1730. A bushy type of plant selected from Sakel by A. R. Lambert and first bulked in 1930.

X1730A. Selection from X1730 bulked in 1931 and now grown commercially on the southern half of the Gezira.

X1730K. A re-selection of X1730A type.

BAR.X1730L. Blackarm-resistant X1730A of 7th backcross origin and containing **B_2**.

BAR.4/5. Blackarm-resistant X1730A of 9th backcross origin and containing **B_2**.

BAR.4/8. Blackarm-resistant X1730A of 7th backcross origin containing **B_3**.

BAR.4/11. Blackarm-resistant X1730A synthesized from the cross BAR.4/5 × BAR.4/8 and containing both **B_2** and **B_3**.

BAR.5/3. Blackarm-resistant X1730A of 9th backcross origin and containing **B_3** and R_2^{RS}.

N.T.2. A selection from Sakel resistant to leaf curl.

N.T.2/36, N.T.2/38, N.T.2/39. Successive re-selections of N.T.2 type.

BAR.N.T.2/41. Blackarm-resistant N.T.2 of 7th backcross origin and containing **B_2**.

BAR.2/10. Blackarm-resistant N.T.2 of 9th backcross origin and containing **B_2**.

BAR.2/12. Blackarm-resistant N.T.2 of 6th backcross origin and containing **B_3**. (The first 3 crosses in this case were not, however, made with N.T.2 but with X1730 type strains.)

BAR.6/2. Blackarm-resistant N.T.2 of 10th backcross origin and containing R_2^{RS} and **B_2**. (The first 4 crosses were not, however, made with N.T.2 but with X1730 type strains.)

S.P.84R. A variety imported from Uganda.

BAR.7/1. The blackarm-resistant component of S.P.84R.

SUS.7/2. The blackarm-susceptible component of S.P.84R.

BAR.7/5.	Blackarm-resistant S.P.84R of 4th backcross origin, carrying $\mathbf{B}_3$ but not $\mathbf{B}_2$.
BAR.7/6.	Blackarm-resistant S.P.84R of 5th backcross origin, carrying $\mathbf{B}_3$ but not $\mathbf{B}_2$.
Deltapine.	A commercial type from Delta and Pine Land Co., U.S.A.
BAR.10/1.	Blackarm-resistant Deltapine of 2nd backcross origin, carrying $\mathbf{B}_2$ transferred from N.T.61/38.
Pump Scheme Strain.	An impure commercial type which originated from Nyasaland Upland.
X.A.129.	From a single-plant selection in Pump Scheme Strain.
BAR.11/1.	Blackarm-resistant X.A.129 of 2nd backcross origin carrying $\mathbf{B}_2$ transferred from N.T.61/38.
BAR.11/5.	Blackarm-resistant X.A.129 of 4th backcross origin carrying $\mathbf{B}_2$ transferred from N.T.61/38.
511D.	From a single-plant selection in Uganda S.G.85.
B.P.52.	A strain imported from Uganda.
S.P.20.	A strain imported from Uganda.
B.181.	A strain imported from Uganda.
N.T.58/39, N.T.58/42, N.T.58/43.	Successive waves of strains originating from a selection made from a Punjab Early outcross.
N.T.61/38.	A Pump Scheme type strain carrying $\mathbf{B}_2$ transferred from Uganda B.31.
N.T.96/40, N.T.96/42.	From a single-plant selection in a cross of 57 × Over-the-Top obtained from Mr. Ducker.
N.T.205/41, N.T.205/42, N.T.205/43.	Successive waves from a single-plant selection in Uganda S.P.20. (N.T.205/43 is homozygous for $\mathbf{B}_2$.)
N.T.206/41.	A single-plant selection from Uganda S.P.84.
N.T.209/41.	From (U.4 × Cambodia) × U.4.

[*Included by courtesy of the Uganda Government.*]

UGANDA.

COTTON EXPERIMENT STATIONS, KAWANDA AND SERERE, PROGRESS REPORTS FOR THE SEASON 1944-45.

KAWANDA AREA

BY

J. D. JAMESON

Senior Botanist.

Part I.

Introduction.

Our knowledge of cotton in Uganda has now reached a stage at which it is desirable to review the whole situation critically. Such a review is beyond the scope of the present report, and it is proposed to publish it as a separate article, which may come appropriately at a time when Corporation officers are beginning to arrive in the country. In anticipation of this review certain key conclusions are briefly mentioned at appropriate places in this report.

Meteorology.

The following table records the rainfall at Kawanda in 1944, together with the average rainfall for nine years at that station, and indicates the principal planting and harvesting months for cotton and food crops.

	Rainfall (inches).		*Planting.*	*Harvesting.*
	1944.	*Mean. 1936–44.*		
January	2·03	2·10	—	Cotton
February	1·39	2·63	—	Cotton
March	5·96	4·16	Food	—
April	5·57	7·05	Food	—
May	3·42	5·16	Food	—
June	1·73	2·61	Cotton	Food
July	4·08	2·06	Cotton	Food
August	2·31	3·23	Food and Cotton	—
September	7·62	4·19	Food	—
October	2·81	3·91	—	—
November	5·99	4·79	—	Food
December	4·40	3·77	—	Food and Cotton
Total	47·31	45·66		

Rainfall was adequate and very well distributed, except that it persisted rather late and interfered with the beginning of the cotton harvest. The food crops, both early and late, did very well indeed. A high proportion of the cotton at Kawanda was planted full early, and in such a long season suffered severely from diseases and pests, with serious results to yield and seed viability.

Conclusions from work done in 1944–45.

Agriculture.

Rotations.—Results cannot be expected for some time to come.

Interplanting.—In abeyance.

Sowing Date.—This is a controversial subject in most countries where the climate allows any latitude, and Uganda is no exception to the rule. But it is a fundamental issue in deciding any cotton breeding programme. Formal experiments on the classical pattern have declared in favour of early planting (May and June), but owing to the possibility of cross interference by diseases and pests between adjacent plots, it is necessary to accept this result with reserve. The actual distribution of cotton planting in Mengo District, in which Kawanda lies, during the ten years 1935–44, was as follows :—

May	5%
June	19%
July	31%
August	32%
September	12%

In spite of propaganda for early planting, this distribution has shown no tendency to change, so it is clear that the peasant is prepared to accept the crop risk which we believe to be entailed by late planting. Therefore our past practice of breeding and testing varieties sown at comparatively early dates has not been suited to the facts, and it now behoves us to adopt, as an important part of our programme, the more realistic plan of breeding varieties suitable for July and August planting, and so help the peasant to minimise his crop risk.

During the period under review an attempt was made to grow, for observational purposes, some out-of-season cotton free from interference by *Lygus*. Isolated plots were planted at Kawanda in November, 1943, and February, 1944, using the Blackarm-resistant varieties KP.28 and S.1021 respectively. The November-sown plot encountered the severest drought for many years and had to be established by watering. Three months after planting, the plants were only four inches high, but after five months they had made excellent pyramidal growth, free from Blackarm and *Lygus* attack, and had set a really excellent crop. The plants were uprooted in June unharvested, owing to the accumulation of stainers and bollworms during the close season for the normal crop, but the potential crop set provided valuable information nevertheless. The February-sown plot was not so satisfactory, as it suffered severely from " new plot " effect, and growth was very uneven. On the better patches of soil the plants developed well and set a big crop. The bolls began to open about the same time as on the November-sown plot, after which the plants were uprooted.

Planting Methods.—A two-acre increase field was divided into 20 plots, making five replications of the following factorized treatments : (*a*) 3 *versus*. 10 seeds per hole. (*b*) 20 *versus*. 40 days to thinning. Ten seeds per hole caused a reduction of 13% in yield, and 40 days to thinning a reduction of 16%. The effects were additive and the worst

combination of treatments yielded 27% less than the best combination. Normally such clear confirmation of a simple agronomic result already worked out in detail at Barberton would be accepted as final. But owing to insect damage the mean yield of this field was only 257 lb. of seed cotton to the acre, so it is intended to repeat this experiment at some future date.

Genetics and Breeding.

Blackarm-resistance.—The transference of the gene $\mathbf{B}_3$ from Gambia Native to BP.52 was discontinued on the grounds that such work would be more suitably done by Corporation staff. The rest of the gene transference programme proceeded according to plan. The amount of infection obtained by spraying with Blackarm suspension was very unsatisfactory, and it was suspected that impurities in the Kawanda water supply might be responsible. In 1945 the suspension was made up with rain water, with entirely satisfactory results, and some of the more important transferences were repeated as a precaution.

Wilt-resistance.—The hybrid between KP.28 ex B.181 (resistant) and KP.40 ex BP.50 (susceptible) was selfed and back-crossed to both parents. The hybrid was also tested against its two parents in a variety trial comprising 27 randomised replications, using single-row plots. Each plant in the trial was inoculated with a culture of *Verticillium*. The percentages of plants which developed symptoms of wilt (after using a square root transformation) were as follows :—

	External Symptoms during Growth.	*Internal Symptoms when Uprooted.*
KP.28	0·25%	12·24%
KP.40	12·56%	38·13%
KP.28 × KP.40	3·05%	21·66%

The figures for the hybrid are close to the geometric means of the figures for the two parents. It is not possible to say whether they are the result of blending inheritance or a simple genetic system. A routine transference of resistance to BP.50 will now be attempted on lines suggested by Mr. Hutchinson, and the less promising work on Tanguis will be discontinued.

Seed Type.—Interesting information was obtained on this subject during the 1945 ginning season. The small departmental ginnery at Kawanda is operated by electricity. Working to capacity on a bulk which was largely clean seeded, it consumed 32 amperes of current. Changing to a fuzzy-seeded type on the same day under comparable conditions it consumed over 40 amperes.

It has always been recognised that a clean-seeded type would be an advantage, because it is easier and therefore cheaper to gin, and would possibly reduce the number of particles of seed coat ripped off and passed into the lint. A clean-seeded type is also easier to handle, packs more closely into bags, and germinates more readily than the fuzzy types. Unfortunately clean-seeded types, considered uncritically

and as a whole, give a lower ginning percentage. A transference of the tufted type (as opposed to the completely naked) to BP.52 will now be attempted, on lines suggested by Mr. Hutchinson, to see whether this type can be developed without impairing the ginning percentage. The completely naked type is also being transferred as a check.

Red Plant Body.—The gene responsible for the red type of plant which we have in Uganda has been identified by Mr. Hutchinson as $\mathbf{R}_1$. Harland (1) has shown that there is a low re-combination value between red plant body and cluster habit. It has been observed on several previous occasions that red plants in Uganda tend to be taller and more open in habit than ordinary green strains. The prevalence of cluster and semi-cluster habit in Uganda varieties will not be discussed in detail here. It is sufficient to say that this observation on red plants draws attention to it as a fact. But the red plants have drawn attention to another character prevalent in our Uganda varieties (by suppressing it) which is not ordinarily associated with cluster habit in the literature. This character is the tendency for dormant axillary buds to develop monopodial branches at any node on the main stem (alongside the sympodial branches), or even at the joints along the sympodia themselves. It is easy to see how this character, by providing a secondary structure for the plant, may compensate for the loss of framework caused by Blackarm and *Lygus* damage. Two recent observations on red plants have provided the proof of this. A late-planted plot at Kawanda, not attacked by Blackarm or *Lygus*, produced large pyramidal plants with extensive sympodial branching and a big crop. An early-planted plot at Serere, severely attacked by *Lygus*, and unable to make any secondary structure, produced tall columnar plants, reaching eight feet or more, with practically no crop.

Maintenance.—The importance of maintaining BP.52 in order to refresh commercial stocks cannot be over-emphasised. The relatively pure seed from Serere was grown on Kawanda main farm, and was also distributed to growers in Kawanda segregated area. The produce from the latter was sent to plant the 1945–46 crop in South Bugerere.

Last season 235 single plants were selected from BP.52 bulk for plant type, lint length and modal ginning percentage. The seed was planted out in progeny rows. After checking for the same characters, and also discarding for low hairiness, their number was reduced to 150. Seed of these was sent to Mr. Peat at Ukiriguru to be tested for jassid resistance, and a reserve fumigated and put in store at Kawanda pending results from Ukiriguru. The remaining seed from these 150 progenies was made into a special bulk and planted in the 1945–46 season in an isolated increase field of rather over one acre at Kawanda.

(1) Harland, S. C. (1934), *Tropical Agriculture*, 11, p. 316.

Variety Trials.—25 varieties were tested in a lattice square at Kawanda. Three new departures were incorporated in this trial :—

(*a*) the field was carefully levelled by hand before planting ;

(*b*) small square plots were used as recommended by Dr. Yates to meet our uniformity position ;

(*c*) planting was delayed until 12th July, to be more in accordance with local practice, although much of the farm was planted early as usual.

The levelling and change of design reduced error variance, though it was not possible to say how much each contributed to this result. The later planting reduced the amount of *Lygus* damage very considerably as compared with other earlier-planted fields on the farm. The later planting and reduced *Lygus* damage between them increased the variety variance very greatly, spreading the varieties over a wide range of yield. This was very important, as it surmounted the difficulty that all varieties tend to yield alike when severely attacked by *Lygus*, and also indicated which varieties are likely to be of value when grown under conditions of ordinary local practice. BP.52 as control yielded 231 lb. of clean lint per acre. The early-maturing variety KP.40 ex BP.50, in spite of some wilt, gave 280 lb. per acre. Derivatives of the late-maturing variety B.181 averaged only 205 lb. per acre. This was a perfectly logical result to obtain with later planting. 280 lb. of clean lint to the acre is a good yield for an experiment station in Mengo District judged by absolute standards. Together with similar results obtained from time to time in the past, it justifies the proposed plan of breeding early-maturing varieties for late planting.

The five varieties BP.52, B.181, KP.28 (ex B.181), X.3/44 (a new mixture of three parts BP.52 and one part B.181) and BC.6/14 (a selection from a first backcross from B.181 to BP.52) were tested in twelve district trials. Over all there were no significant differences in yield of clean lint, so little information was obtained on the variety question. But the trials were interesting from the point of view of sowing date. There were eight trials in Mengo District, after setting aside trials in outlying districts with different rainfall systems. Of the eight trials five were planted in May, and these all yielded considerably less than the three trials which were planted later. This result confirmed the general experience of the season at Kawanda Farm.

Spinning Tests.—BP.52 gave the best spinning values from samples produced in the 1943–44 season. Mixtures and backcrosses containing elements of BP.52 made up the next best class. Nevertheless there is an increasing tendency to comment adversely on the appearance of BP.52 yarns. Samples of BP.52 are frequently immature, are generally coarser and of lower yarn strength than in previous seasons.

Seed Distribution.—The distribution of the mixture X.3/38 proceeded a stage further in Masaka District. Certain areas in the

rest of Buganda received a new wave of BP.52 seed, the benefit of which was well marked in the routine examinations for seed purity in 1945. Seed purity is judged by the proportion of clean seeds which appears in ginnery stocks. BP.52 has a fuzzy seed, and the clean seeds derive from the old Buganda Local stock. Clean seeds have been sorted out and grown beside BP.52 at Kawanda. Nearly all the plants were manifestly off-type, so the routine examinations, if not a straight measure of impurity, are something more than a mere index.

Plot Technique.

No new uniformity material was dealt with during the season, but a variety of designs were tried out in twelve experiments with different crops, not only for their efficiency in statistical analysis, but also for their convenience in day-to-day field operations.

Two uniformity trials have been laid down in the 1945–46 season and Mr. Manning is now available in Uganda to deal with them and previous results, so it is proposed to postpone further detailed discussion for the present. In general, if the rows are planted along the contour, a plot composed of numerous short rows is the most efficient for statistical analysis, but it entails the great practical disadvantage that it is necessary to walk forwards along the rows, instead of sideways, to make a visual comparison between two plots.

Last year it was said that pronounced fertility changes were found in a gradient-wise direction. It is not yet clear how much of this fertility change can be ascribed to defects in the planning of cultural operations, which could be remedied, and how much of it is inherent in the soil itself. For example, if fields are ploughed so that an open furrow is left down the middle of each, there will be pronounced fertility changes across the field. Careful levelling of certain fields before planting does seem to have improved the position materially, and it should not be impossible to organize ploughing so as to avoid this trouble.

Entomology.

Dr. Taylor's work on *Lygus* has now been published (1).

The most notable occurrence of the season was a severe infestation of stainers on Kawanda farm, which did great damage to the early-planted crop and seriously impaired seed viability. The writer has not seen such a population before anywhere in Uganda. Unfortunately, owing to staff changes, continuous observations by an entomologist were not possible throughout the whole season. *Dysdercus superstitiosus*, *D. nigrofasciatus* and *D. fasciatus* all played some part. The last two were most conspicuous in numbers, particularly *D. fasciatus* at the end of the season, but numbers are not necessarily a guide in assigning responsibility for damage done.

(1) Taylor, T. H. C. (1945), *Bull. Ent. Res.*, 36, 121.

MYCOLOGY.

Natural infection by Blackarm and wilt was not particularly serious. At Kawanda one field closed down with *Alternaria*, but for the good reason that it was carrying the heaviest crop on the farm.

PROGRAMME FOR 1945-46.

AGRICULTURE.

Rotations.—Unchanged.

Interplanting.—Still in abeyance owing to shortage of staff.

Sowing Date.—No cotton to be planted at Kawanda until the last week in June, as an experiment to observe the behaviour or a late-planted crop free from interference from earlier-planted cotton. District variety trials to be planted at realistic (later) sowing dates. An area of about a thousand acres in Kabula, Masaka District, to be planted from October to January, to crop in June and July. Being south of the equator this area may be more akin to the Tanganyika Lake crop.

Planting Methods.—Omitted for the present owing to shortage of staff.

GENETICS AND BREEDING.

Blackarm-resistance.—Unchanged.

Wilt-resistance.—Programme as modified by Mr. Hutchinson.

Seed Type.—Transference of the fuzzy tip type to BP.52.

Red Plant Body.—Renewed studies in connection with cluster habit and branching systems.

Tomentosum.—Transference of *G. tomentosum* hairs to MU.8A and BP.50 as a possible means of gaining resistance to *Lygus*.

Okra Leaf.—Transference of okra leaf to BP.52 to observe the effect of a more open ecoclimate on insect behaviour.

REPORT—PART II.

There are no detailed experimental results to be recorded in Part II of the Progress Report this year.

SERERE AREA.

PROGRESS REPORT—Part I

BY

P. E. WEATHERLEY.

Introduction.

The 1944–45 season was largely one of routine testing and of rounding-off the work on Blackarm-resistance. As usual the work on cotton was dominated by *Lygus* attack, which began later than usual so that cotton sown in April–May tended to escape damage until after flowering, but all cotton on the experiment farm except the very late sowings was severely attacked.

During this season exploratory work was started on cotton physiology with a view to elucidating certain aspects of *Lygus* attack.

Meteorology.

	Serere Rainfall (inches).		*Sowing.*	*Harvesting.*
	1944.	*Mean 1921–44.*		
January	0·12	0·83	—	Food and Cotton
February	2·89	2·46	Food	Cotton
March	2·07	3·63	Food	—
April	7·30	8·10	Food	—
May	7·40	7·07	Food and Cotton	—
June	4·44	4·40	Cotton	Food
July	3·29	4·55	Cotton	Food
August	6·14	6·31	Food and Cotton	Food
September	8·46	5·87	Food	—
October	5·44	4·35	—	Cotton
November	7·14	3·90	—	Food and Cotton
December	3·63	2·10	—	Food and Cotton
Total	58·32	53·57		

It will be seen from the rainfall figures above, that during the first eight months of the year there was no marked deviation from the average. On the other hand, the second rains were both prolonged and heavy, the combined total of September, October and November outstripping that of April, May and June, an unusual distribution for Serere. These unusually heavy second rains undoubtedly favoured the growth of late-sown cotton and second rain crops generally, but damaged early-sown cotton to some extent.

Conclusions from work done in 1944–45.

Agriculture.[1]

Manurial Trial.—This was in the third year of its fourth cropping cycle, manures having been last applied before the 1942 cotton planting. It was under groundnuts, the yields of which strongly reflected the dressings of farmyard manure. The plots with the largest dressings yielded almost three times the unmanured control.

Cotton Seed and Meal Manurial Trial.—Resting.

Cotton Seed and Ash Manurial Trial.—Resting.

[1] The assistance of Mr. R. K. Kerkham, Agricultural Officer, is gratefully acknowledged.

Fertility Experiment.—Cotton crops were above average and responses to farmyard manure were well marked, especially in the second circuit of the rotation. *Eleusine* millet, considered a good indicator of soil fertility, gave a clear-cut increase in yield with increased resting period and decreased period of cropping. (The two treatments being complementary in the design of the experiment.)

Interplanting Experiment.—It would be an undoubted advantage to the grower if cotton could be interplanted late in the year with a crop such as cassava or pigeon peas, which would cover the land through the dry season after cotton harvesting, and, at the same time, yield a supply of food about the middle of the following year. This experiment was revived (*see* 1942–43 Report, p. 100) to investigate the effect on cotton yields of this " telescoping " procedure.

Cotton was sown in mid-June and interplanted with cassava and pigeon peas. Both of these crops were planted in August and October. The spacing of the cotton was the normal 3 feet by 1 foot, the interplants being between rows and spaced 6 ft. by 6 ft. The results indicated that the earlier interplanting depressed cotton yield, but no depression of cotton yield was detected with the later interplanting. The " take " of the interplants was poor in October, nevertheless the procedure was justified since the cotton was unaffected, and extra food supplies gained.

N.P.K. Experiment.—This was repeated on the same land as in the previous year, the manures being reapplied to the same plots after sowing with cotton. The manures produced no significant differences in yield of seed cotton, and few of the field measurements carried out attained statistical significance. It is felt that the lack of uniformity of the land under trial rendered the experiment insufficiently precise to detect anything but very large responses, which were not likely to occur on land of high fertility status, such as this.

Genetics and Breeding.

Genetics of Blackarm-resistance.—One hundred and fourteen selected strains, representing thirty-three varieties, were grown as small bulks for increase, and sprayed with " Blackarm suspension " as a further test for resistance. Thirty-one strains were eliminated for relative lack of resistance and other characters in the field. Finally, from a consideration of laboratory data, twenty-eight strains were selected for maintenance for possible use in the future, and thirteen for further increase.

Yields from these bulks were poor, probably owing to a very severe attack by *Lygus*, so that the increase was less than was hoped. For this reason the quantities of seed available allow for the immediate testing of only twenty-four strains in variety trials here and at Kawanda.

Progenies from resistant phenotypes selected in the F_2 generation between BP.52 and resistant N.17 showed marked resistance, and no further elimination for Blackarm was necessary. The absence of

susceptible plants in the F_3 implies that homozygous and heterozygous plants were distinguished and the former selected in the F_2 generation. Seed from the F_3 is to be further increased in bulk.

Type Collection.—Maintained.

Variety Trials.—There were two variety trials. In the first, five varieties were compared at six sowing dates ranging from April to September. The results followed previous experience of these trials, the early sowings giving the highest yields of seed cotton. This was in spite of the very heavy late rains which presumably favoured the late-sown cotton.(1) The Bukalasa strains B.181 and BP.50R gave the highest yields at all but the latest sowing, when BP.52 was best, and N.17 derivatives the lowest yields at all sowings. The *Lygus* leaf damage counts revealed no varietal differences.

In the second trial Blackarm-resistant selections were compared with their parental less-resistant types. The relative resistance of the selections was well demonstrated by the routine lesion counts, the number of lesions being reduced to less than half. The best of the N.17 selections gave 255 lb. of lint per acre as compared with 156 lb. of lint per acre from the best N.17 local bulk. The highest yields were obtained from B.181 and its resistant derivatives, the best of which yielded 274 lb. of lint per acre. The trial appeared to be heavily attacked by *Lygus*, but no varietal differences in this respect were revealed by the leaf damage counts.

District variety trials were conducted at nineteen centres. BP.52 and B.181 were tested against N.17 and the selection S.4105 (ex N.17.M2) at all centres. In addition SP.84 (ex U.4/4/2) was included in Usuku, the selection S.3104 (ex N.17.M3) in Busoga, and BP.50R in the remaining districts. B.181 had fewer Blackarm lesions than the other varieties at every centre, and BP.50R, where it was grown, had fewer lesions than the remaining three. Once again B.181 had less Blackarm than SP.84 in Usuku.

In general, the highest yields of lint were obtained from B.181 which was equalled by BP.50R at those centres where it was grown, but barely so by SP.84 in Usuku. BP.52, whilst considerably lower in yield than B.181 and BP.50R almost everywhere, was the equal of, or better than, N.17 control. The N.17 mass selections were better than N.17 bulk in Mbale and Busoga, but little better elsewhere.

Out-pollination Test.—In 1943 an out-pollination test was performed using a few isolated green plants sown in a field of red cotton. In 1944 a less precise test was carried out to investigate the incidence of cross-pollination between plots of cotton separated by various distances. Use was made of the fact that the leaves of the hybrid between the okra-leaf type of cotton and the normal type are intermediate in form and therefore distinguishable from the parental types.

(1) The validity of sowing date trials is one of the subjects to be discussed in the article mentioned in the introduction to the Kawanda report.

Small plots about 4 yards square were sown in various situations on the experiment farm being at various distances from other cotton plots. No other cotton was growing in the vicinity. The plots were harvested and two random samples of the seed of each grown in 1945 and the proportion of hybrids recorded. (*See* table below.)

	Number of Plants.			*% Hybrid.*
	Okra Type.	*Hybrid.*	*Total.*	
1. Plot 3 feet distant from nearest cotton on two sides ...	(1) 47	16	63	
	(2) 46	17	63	
	93	33	126	26·2
2. Plot 17 yards from nearest cotton on three sides ...	(1) 68	1	69	
	(2) 53	3	56	
	121	4	125	3·2
3. Plot 70 yards distant from nearest cotton on one side...	(1) 68	4	72	
	(2) 74	0	74	
	142	4	146	2·7
4. Plot 140 yards distant from nearest cotton on one side	(1) 76	3	79	
	(2) 67	1	68	
	143	4	147	2·7

It should be mentioned that Plot 1, which was sown between two variety trials having red guard rows, showed a proportion of red hybrids. Of course, all the red hybrids were also hybrid for the laciniate character. It is interesting to note that the 1943 out-pollination test with single plants gave a value of about 30%, only slightly greater than Plot 1 in this trial.

Spinning Tests.—Samples from the 1943–44 crop showed that whilst BP.52 gave the strongest yarns throughout, they had poor appearance, whereas B.181 gave the weakest yarns everywhere except in Teso and Lango, but were good in appearance. The N.17 cottons gave, in general, yarns of intermediate strength and appearance.

Small-scale tests again demonstrated the superiority of BP.52 over the Bukalasa and N.17 strains.

Seed Distribution.—The increase of improved N.17 through Mulondo and Labori-Kadunguru continued. Serere farm grew forty acres of B.181 destined to further the supply of seed to North Teso through Lalle. BP.52 reached the whole of Madi sub-district in the West Nile zone, and also the whole of South Mbale zone, replacing SG.29 in each of these areas. In 1945 BP.52 has reached the whole of the West Nile zone, and also North Mbale zone, thus eliminating the last SG.29 in the country. The increase of B.181 is proceeding in North Teso.

Cotton Physiology.

This work was started with the aim of throwing light on the relationship between the cotton plant and the Capsid, *Lygus*. Previous work by entomologists(1) in the Department has brought out the following salient features: (1) Only very young tissues are attacked. Mature tissues appear to be immune. (2) Old plants are less susceptible

(1) Taylor, T. H. C. (1945), *Bull. Ent. Res.*, 36, 121.

than young plants. (3) Damage is increased in severity under humid conditions promoting saturation of the tissues with water. (4) In the field, plants described as " succulent " are said to be attacked more than their " drier " neighbours. Readily attacked tissue must, therefore, be immature, on a plant not beyond a certain age, and not in a condition of " water strain."

Whilst it is unlikely that there is a single unifying explanation of these facts, it was believed that the water factor might play an important part in *Lygus* attack. For this reason it was considered expedient to start by making a generalized study of the relationships between water and other leaf-tissue constituents ; to explore the changes which occur during the maturing and ageing of cotton plants ; and to investigate the differences between young, mature and old leaf-tissues found on a plant at a given time. In the work of this season most attention has been paid to changes occurring during the growth and ageing of cotton plants, although preliminary data have also been obtained on the differences between young and old tissues.

Although mature tissues are not attacked by the insect, it was considered necessary to investigate some of the constituent relationships in mature tissue first, because the expanded lamina lends itself to more precise treatment than buds. It is hoped that this preliminary study of mature tissue will point the way to significant measurements on bud tissue, which might not have suggested themselves in a direct study of the latter.

In practice, discs of leaf lamina were punched with a cork-borer, a fixed number of discs constituting a sample. Such samples were taken periodically from the seedling stage to maturity in cotton plants sown on six different dates ranging from April to September. Thus, at a given time, plants of various ages were sampled, so that age and environmental effects could be distinguished.

Whilst it would be premature to discuss the results in detail, the work of the first season has served to emphasise the importance of the choice of basis for expressing age and environmental changes in such leaf-tissue constituents as water or carbohydrates. Water expressed as a percentage of dry weight gave quite a different picture of water content trends from water expressed on an area sample basis.

Information gained incidentally on seasonal trends in leaf carbohydrates, might throw light on the sowing date problem at Serere.

Entomology.

Taylor(1) states that in the Serere area the initial population of *Lygus* in cotton arises by dispersal from nearby millets. It was suggested, therefore, that the extensive millet cultivation on Serere Experiment Farm during the last ten years might have provoked an undue measure of *Lygus* attack on adjacent cotton. In order to test this no first rain millets were grown on the experiment farm this

(1) Taylor, T. H. C. (1945), *Bull. Ent. Res.*, 36, 121.

season, and a millet-free zone was reserved on all sides of it. The nearest early-sown millet from which *Lygus* might have dispersed was some sorghum a quarter of a mile distant. As far as could be seen by Mr. Mubbiru and botanical staff making general observations the *Lygus* attack was as severe as ever, and it would appear that this degree of segregation from millets failed to reduce the attack.

Mycology.

Blackarm.—*See* Genetics section.

PROGRAMME FOR 1945-46.

Agriculture.

Manurial Trial.—Cotton.

Cotton Seed and Meal Manurial Trial.—Index crops of groundnuts and sorghum in second rains.

Cotton Seed and Ash Manurial Trial.—Resting.

Fertility Experiment.—Continues.

Interplanting Experiments.—The 1944–45 trial to be repeated with cassava only. A second trial will be revived (*see* 1942–43 Report, p. 100) in which cotton will be interplanted with Canadian Wonder and tepary beans.

N.P.K. Experiment.—This will be cropped with Eleusine followed by *Vigna* to test residual effects.

Genetics and Breeding.

Genetics of Blackarm-resistance.—Resistant material to be increased and tested in trials.

Type Collection.—To be discontinued apart from a few types of local interest.

Variety Trials.—Routine.

Plant Physiology.

General study of cotton physiology in relation to *Lygus* attack to be continued.

REPORT—Part II.

There are no detailed experimental results to be recorded in Part II of the Progress Report this year.

TANGANYIKA TERRITORY.

AGRICULTURAL CONDITIONS AND THEIR RELATION TO COTTON-GROWING IN THE LAKE PROVINCE

BY

J. E. PEAT AND A. N. PRENTICE.*

INHERENT AGRICULTURAL CIRCUMSTANCES.

The Lake Province of Tanganyika, situated around the south end of Lake Victoria, consists of seven districts. Of these, four districts, Mwanza, Kwimba, Maswa and Shinyanga produce almost all the cotton. These four districts (excluding geographically in Mwanza District the country to the west of Smith Sound and to the north of Speke Gulf) comprise Sukumaland. The only other cotton-producing district of any importance is Musoma, although Bukoba district, adjacent to Uganda, used to show a very small production. The area of the four main districts is roughly 20,000 square miles ; the present cotton production comes from a block of about half this size, very roughly 100 miles square. The cotton markets, shown on the map, reflect fairly accurately the actual localities of production.

Cotton production has ranged in the last ten years from 17,000 bales to 50,000 bales a year, with a mean of around 34,000 bales of lint a year. The Table analyses the production, by district and type of season.

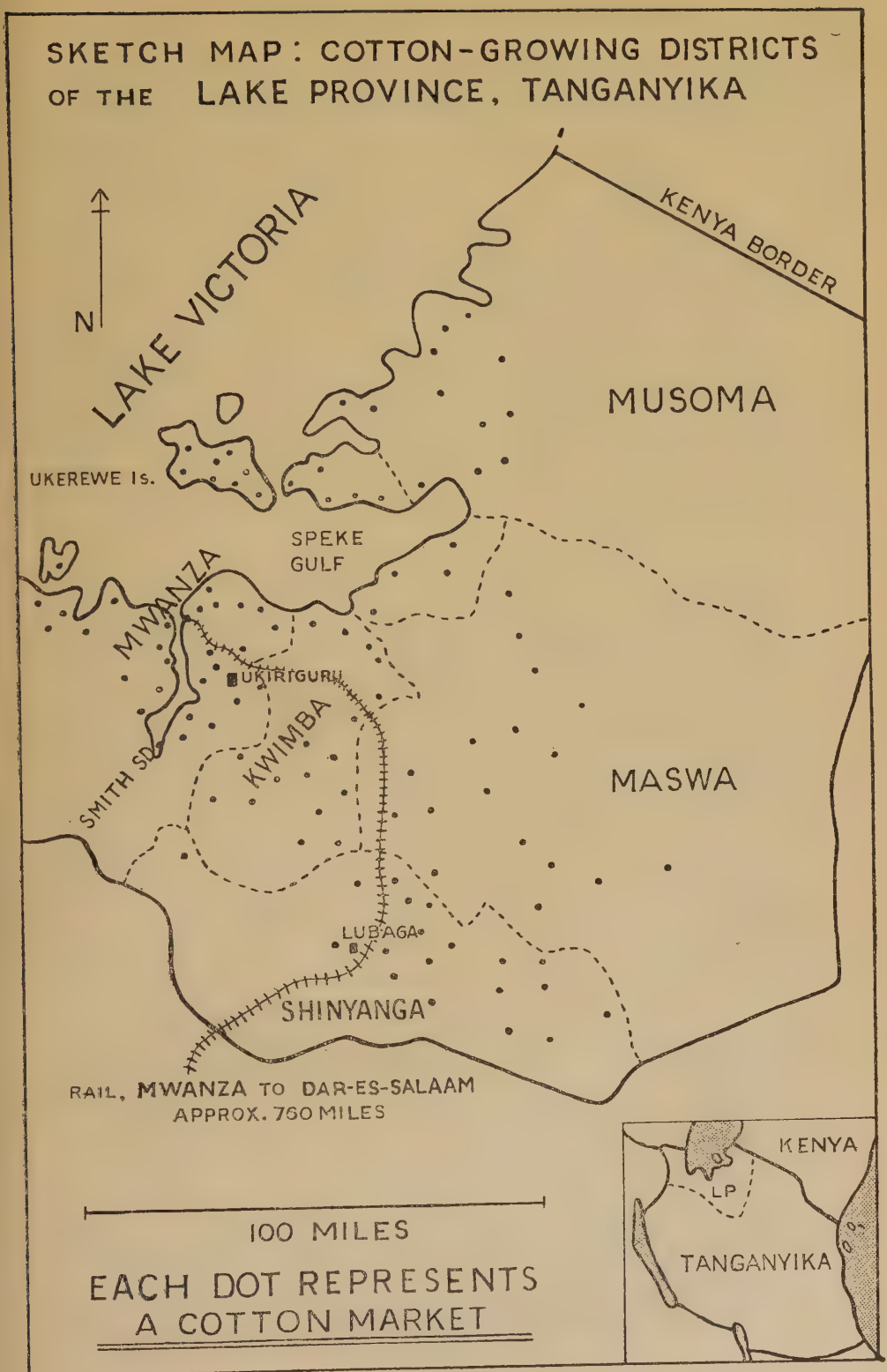
COTTON PRODUCTION IN AVERAGE, FAVOURABLE AND POOR SEASONS (400 LB. BALES).

District.	*10-Year Average 1935–44.*	*(Contribution to Province total, %.)*	*Generally good year (1941).*	*Generally bad year (1944).*
Mwanza	17,300	(52%)	24,400 (49%)	11,400 (67%)
Kwimba	5,900	(18%)	7,700 (15%)	2,500 (15%)
Maswa	4,500	(13%)	7,000 (14%)	1,600 (9%)
Shinyanga	4,500	(13%)	9,000 (18%)	900 (5%)
Musoma	1,300	(4%)	2,000 (4%)	700 (4%)
Province Total	33,500	(100%)	50,100(100%)	17,100(100%)

It can be seen that the biggest production comes from Mwanza, reasonably near the Lake shore, where growing conditions are easier ; and that in a difficult season the falling-off in production is more marked in the more inland districts such as—the extreme—Shinyanga.

There are nearly a million men, women and children in the four main cotton districts, reaching in the more populated areas a density of up to probably 400 souls to the square mile—a dense population where the soil is predominantly light. In such closely-settled parts—typically parts of Mwanza and north Kwimba—possibly half of the land is under cultivation, and around 5% of that half may be under cotton. In other parts of Sukumaland, appreciably less land will be under

* Mr. R. B. Allnutt, Acting Senior Agricultural Officer of the Lake Province, has kindly provided figures and checked statements of fact. Expressions of opinion are the responsibility of the Corporation officers.


SKETCH MAP: COTTON-GROWING DISTRICTS OF THE LAKE PROVINCE, TANGANYIKA
N
LAKE VICTORIA
KENYA BORDER
MUSOMA
UKEREWE Is.
SPEKE GULF
MWANZA
UKIRIGURU
KWIMBA
SMITH SD.
MASWA
LUBAGA
SHINYANGA
RAIL, MWANZA TO DAR-ES-SALAAM
APPROX. 760 MILES
100 MILES
EACH DOT REPRESENTS A COTTON MARKET
KENYA
LP
TANGANYIKA

cultivation, but the proportion under cotton may well be steady. (Figures must be guesswork : accurate survey information is not yet available. Naturally, also, figures would vary from year to year, depending on seasons, the pressure to plant either food or cash crops, prices, and so on.)

Cotton near the Lake Shore is planted normally in November and December, but generally somewhat later further south. The up-rooting date is August 31st. Rainfall and not temperature determines the start and the length of the cotton-growing season.

Temperature ranges are not great. At Ukiriguru in October, the hottest month, the mean maximum for the month rarely touches 88°F., and in the rest of the hot season the monthly mean maxima are around 82–84°. Inland at Shinyanga, the corresponding figures are about 3° higher. The mean minimum at the same period is around 64°F. In July, the coldest month, the mean maximum at Ukiriguru remains around the 83°F. mark, but the mean minimum drops to an average of around 58°F.

The rainfall is earlier, slightly greater and the season slightly longer close to the Lake shore. There the rains may start towards the end of October or early November, and continue through until the end of May–June. Heavy storms (say, over 2 inches in 24 hours) are not so common as further south. Though there are not two clearly marked rainy seasons, there are often droughty periods in January, February, early March—but not in all years. Further south towards Shinyanga the rains are later in starting, their intensity at times is heavier, and they tend to shut down earlier. The mean seasonal fall, 1st November–30th June, might be put at around 25–30 inches. The wetter parts of the Lake shore might in many years average around 40–45 inches. At Ukiriguru, about 17 miles back from the Lake, the mean seasonal rainfall over a 14-year period is 28 inches ; the highest 39 inches, the lowest 17 inches. At Lubaga, Shinyanga, the mean over a 12-year period is 31 inches ; the highest 49 inches, the lowest 22 inches. Throughout Sukumaland the period June–October is normally rainless.

The greater part of the cotton-producing area is underlain by granite. Near the Lake, the country is in the main broken ; rocky hills of uniform height are separated by gently sloping valleys. Further south the country is one of " wide undulating plains interspersed with low ridges, hill blocks and ranges, which do not rise over 1,000 feet above the general level of 3,800–4,000 feet above sea level." (Malcolm Report.)

The soils are essentially of granitic origin in the north of the Province, but there is a range of types, each type with a local name and with characteristics reasonably well understood by the cultivators. The main hill soils are deep but light, and easily worked, and where they have been cultivated over a considerable period of years they are exhausted. Similar soils more recently brought into cultivation

are still fertile. In the valley bottoms are the " black cotton " soils. In the rolling undulating country the soil types are, on the whole, heavier and less easily worked. There are areas of red soil derived from the upper Basement Complex invaded by granite. In the south there are areas derived from a calcareous lake bed lying over the earlier terrestrial sands.

The four districts comprise part of what is known as the " Cultivation Steppe." Where population is dense the vegetation has been influenced greatly by human activities. Thus, central Sukumaland presents a picture of wide, rolling, almost treeless plains. In the north the areas of densest population follow the *Combretum* country. Settlement is now taking place in *Brachystegia-Isoberlinia* woodland in the west of Mwanza ; but little is yet known about how long reasonable yield can be maintained there. In the south much of the cultivation is in *Acacia-Adansonia* and Acacia thorn country.

Considerable areas are still closed to human occupation because of tsetse fly.

The Agricultural System and Practices.

The agriculture is, with negligible exceptions, entirely peasant African ; ploughs are very little used ; the hand hoe is the basis for all cultivation. The people are on the whole industrious, and have a good knowledge of the soils and the food crops best suited to the particular soil types. But by no means could they be described as good husbandmen. They are a cheerful people, essentially optimistic about their farming and generally with little thought for the future, or for the steps that might be taken to offset many of the difficulties that apply to their agriculture. They are highly tractable ; the agricultural administration is through their organised society of village headmen, chiefs, and Native Authorities.

The people have little understanding of, or interest in, improved agriculture or agricultural hygiene ; and whatever might have been practised in the past in the way of bush fallowing there is now little or no serious attempt made to maintain or restore fertility, or even to prevent soil loss—other than measures initiated through the Native Authorities, and enforced by pressure. On the credit side, the cattle graze the crop residues in the lands, and crop legumes are interplanted in the grains.

Throughout Sukumaland there are somewhere around two million head of cattle. In some areas the cattle population is excessive for the grazing available and in some years the dry-season mortality is high. Cattle are looked upon as wealth and a measure of prestige ; they are used for dowries and altogether have a value quite over and above their simple economic value. At present cattle prices are high, but even given this there is a marked disinclination to sell ; during the war Government had to make arrangements for compulsory

sale of the stock (5% in Mwanza, 7% elsewhere) to keep up meat supplies for military and civil needs. There is a market for cream for ghee-making, and a market for hides.

Except under considerable pressure through the Native Authorities very little use is made of manure, though crop responses to its application are worthwhile on the light soils.

On the light lands the cultivation is on 5ft. broad-based ridges, now, after years of guidance, approximately on the contour. These ridges are split each season. Attempts are being made to get them tied with smaller cross ridges to hold rain and to stop loss of the finer soil particles. On the heavier lands much of the cultivation is on the flat ; experience is showing that on some of these soil types ridge and tie-ridge cultivation would be a big improvement here also.

On the lighter soils the main food crops are bulrush millet and cassava, with lesser amounts of sorghum, sweet potatoes, and maize—of which the people are fond. On the heavier soils, sorghum is the main food crop, the legumes are generally interplanted in the grain crops.

Over and above soil exhaustion and other soil troubles, and the vagaries of the weather, sorghum and millet crops can be seriously reduced in some years by stalk-borer damage, bird loss, and loss from the semi-parasitic weed *Striga helmonthica*. In most years, somewhere or other in the Province, the food position causes anxiety. There is the ever-present fear that one year a combination of unfavourable circumstances may cause widespread famine.

Though not the only factor leading to food shortages, the exhaustion of great areas of the more easily cultivable soils is undoubtedly the most important. The troubles resulting from this soil impoverishment will become worse as the newer areas, to which people can now move, in their turn become exhausted. The inculcation of a sounder system of husbandry than exists at present is essential.

Apart from the income from cattle, cotton is far and away the most important source of income to the people, and the dominant cash crop. In the past five years an average of £250,592 a year has been paid out through the markets for cotton, compared with £39,678 for rice, £26,639 for groundnuts, and £15,972 (2 year average) for chick pea. Over and above these amounts are the indirect benefits to the Province —ginning, transport, and railway freights. In much of the cotton area, rice-growing depends on the holding up of storm water in small catchments ; thus in dry years the rice production is seriously reduced. There are other areas where in most years satisfactory rice crops are grown. But as a large-scale cash crop it cannot be considered seriously in the economy unless schemes for irrigation can be started. Groundnut yields are in the main low—markedly so in droughty years—and the return brought to the cultivators cannot compare with that brought by cotton. If post-war prices are good enough, chick pea (*Cicer*

arietinum) should become an increasingly important cash crop. It grows well on the heavier lands, can be planted late in the season, and flourishes with little rainfall.

Economic Attractiveness of Cotton.

It would seem that associated with cattle products much of the post-war cash crop economy of these districts should be built around cotton, and a cash crop economy would seem to be essential. (Most of the social measures deemed desirable are contingent, in the end, on a raised standard of living of the people.) At present, however, cotton is very badly farmed, in some areas exceedingly so ; good crops, up to the standard of the Station crops, are very few and far between, except in the richest areas. Cotton-growing must be associated with an improved use of the land and better husbandry.

In order to ensure that a sufficient area of land is kept under cultivation and to provide a money reserve against famine, the Native Administration, on the advice of the Provincial authorities, requires every African in suitable areas to plant a portion of his land in cotton, supposedly half an acre per taxpayer in some areas and one acre in others, though in actual fact preliminary survey figures show the acreages generally to be considerably less than those stipulated.

The growing of cotton is part of the Provincial economic effort ; and is partly an insurance against famine, that the people may have funds, if need be, to buy food. Naturally at present a great deal of cotton is planted on land in no state for cropping and yields a miserable return.

When reasonably well farmed in suitable areas, cotton is a crop suited to the conditions. Being deep rooted and thus fairly drought-resistant it can come through the drought periods, often a feature of the cropping season. But unless the standard of native husbandry can be raised, fertility restored at least in part in the more exhausted areas, and maintained in the newer areas, the production of cotton must decrease as the level of fertility falls, and the people of necessity become more and more concerned with growing food.

Without worth-while survey figures (now being obtained) it is difficult to give a mean figure for the Provincial seed cotton yield per acre. It can be said that in large areas the mean yield is low, under 250 lb. per acre. Good areas might average, in a good year, up to nearly the 1,000 lb. per acre mark. Given reasonable husbandry, and no increase in pest attack, somewhere around 500 lb. per acre could well be the " floor " for Sukumaland in many years, and in the better seasons in the better areas mean yields higher than this should be expected. Near the Lake shore, the longer growing season allows greater recovery than in Rhodesia or South Africa from some forms of insect attack.

At Ukiriguru, situated in an exhausted area, mean yields over a period of years on the suitable soils should reach 1,000 lb. per acre, with manuring and reasonably good farming—possibly more, given good jassid-resistance. Possibly 80–90% of the seed cotton would be Grade A in most years. Grade A last season fetched 14 cents per lb., but even at 10 cents, with such yields, the return is good. Grade C (the only other commercial grade of seed cotton) sells at 1–3½ cents. per lb.

At Lubaga, on fertile soil, heavier but shallower than the main Ukiriguru type, the yields over a run of years would probably be lower, and certainly more erratic than at Ukiriguru. The percentage of Grade A is usually markedly lower because of stainer attack.

In some areas much of the cotton is picked with too much trash and leaf mixed in it, lowering grade. Here, as in other directions, guidance is needed. The usual practice is for seed cotton to be picked over by hand before marketing, separating out the Grade C cotton.

Cotton Variety.

There has been a certain lack of clear aim about what was required and what was intended in some of the seed-issue decisions for the Lake Province. This was perhaps unavoidable before some assessment of the problems was made and a clear idea obtained of what was needed.

The old original seed, " Local," is a mixture, mainly of Uganda origin. It is jassid-susceptible, and has a leisurely fruiting habit ; but experience has shown it to be better-cropping than was at first thought, given—and this is important—freedom from jassid attack, a light stainer attack affecting the late crop, and a long growing season. The lint quality is fairly good though the ginning percentage is on the low side. In the north of the Province " Local " was replaced by the two derived strains Mz.561 and (in Ukerewe Island) Mz.457. Mz.457 had no better jassid-resistance than " Local," though it appeared to have fairly good lint quality ; it was scrapped after the seriousness of jassid was realised. Mz.561 now covers the whole Province. It has some jassid-resistance, but not nearly enough for a bad jassid year. It has much the same quality of lint and much the same ginning percentage as " Local." Under reasonably good growing conditions it is no better yielding than " Local," but when circumstances necessitate late planting, and there is pest attack, it is a better cropper.

In Shinyanga, " Local " was replaced by the old Barberton strain U.4/4/2, and later, partially, by another old Barberton strain U.4/998. Neither was sufficiently well suited to the conditions, and in an attempt to even up the lint quality for the Province they have been replaced by Mz.561. It has to be appreciated, however, that lint quality is determined by the growing conditions as well as by the strain grown. Where growing conditions in some years are difficult, the lint quality is bound to be affected adversely.

A high degree of jassid-resistance is essential for any strain for the Province. This, and the present need for providing lint of a quality to satisfy Indian requirements from East Africa, determine the breeding programme. The lint quality aimed at is thus at present determined somewhat arbitrarily by market requirements, and not primarily by the agricultural circumstances and pest position. Plant vigour is also necessary to get cropping capacity under the poor conditions generally prevalent. The combination of jassid-resistance and lint fineness is not easy to obtain ; but several likely strains are now at the testing stage. The provision of a vigorous, highly jassid-resistant, strain should be a big improvement in years of bad jassid attack.

Pests and Diseases.

Jassid, stainer, *Calidea*, Capsid, American bollworm and—possibly more seriously in some years than has been suspected—Blackarm disease, play a big part in lowering yields. In the seriousness of their attack they vary from year to year and from district to district.

Everywhere jassid damage can be very serious, especially on the stunted plants on exhausted soils. In such conditions the length of leaf hairs and therefore resistance, is reduced by poor growing conditions. A high degree of jassid-resistance is essential. In some seasons, however, jassid damage can be quite unimportant.

To the south of the Province, stainers—*Dysdercus superstitiosus* and *D. nigrofasciatus* as the early stainers, and *D. fasciatus* and *D. cardinalis* as the later stainers, and *Calidea dregii*—cause serious damage in most seasons. At Lubaga, in a bad year, 60% of the seed cotton may be classed as Grade C, and this measure of loss does not take into account the loss in bolls that do not reach the picking stage. In other adjoining districts the severity of the stainer-*Calidea* attack precludes the economic growing of cotton. In the centre and north of the Province stainer damage affects more the late crop ; there, in some years and some areas, the percentage of Grade C may be of the order of 15–30%. In other years, and other areas, the damage may be almost negligible. Over the Province as a whole, the amount of Grade C cotton has averaged about 11% of the total crop marketed during the past decade. (Because of the wide disparity in price of the two grades, the marketed proportion of Grade C is lower than that actually present in the field.) The damage caused by the *Calidea* type of stainer is difficult to assess : there may be a population of, say, 30,000 to the acre in the crop one week, and the following week individual specimens may be difficult to find.

In wet years, on the richer soils in the north of the Province, Capsid damage may ruin the crop. Such striking attacks are not common : but probably in most years, especially in the better areas and on the better soils, there is a steady loss of small buds and growing points from Capsid damage. Capsid damage is unimportant in Shinyanga district.

On the Stations loss of crop is caused in some years by American bollworm. It is thought that this is partly a Station breeding-up on areas of pigeon pea and early-planted maize. But in many years there is also a steady American bollworm loss in the better-grown native crops. Partly it can be associated with the planting of early maize in seasons when early rains allow of this. Spiny bollworm may be a factor in some years in Shinyanga district.

On the poor soils aphis stunts the plants in the dry spells liable to occur in January–March. The plants grow away when the drought breaks, but aphis-damage assists in throwing the crop late.

The Blackarm position is not yet appreciated. This past season in the north of the Province there was Angular Leaf Spot, and Bacterial Boll-rot loss, and undoubtedly Blackarm damage. How serious it may be cannot yet be said ; it seemed to be a factor especially in the very poorly grown crops, and it will probably be worth while adding Blackarm-resistance to any strain to be issued.

With the possible exception of *Alternaria* in some seasons in the south, fungous diseases seem unimportant.

Seed Supply, Ginning and Marketing.

The seed cotton is bought in approved markets and buying centres, at a price fixed by Government for each season or period. The buying price is fixed on a formula. The seed cotton is transported from the buying centres to the ginneries by the ginnery firms—all Indian. At present the buying centres are zoned to each ginnery. This is a war measure to reduce transport, but possibly some such system will become permanent. There are 12 ginneries with an average outturn of anything up to 5,000 bales per season. Most of the ginneries would turn out around 3,000 bales in an ordinary season. The ginning season is from July until September–October. After passing through an opener the seed cotton is roller-ginned—which seems a luxury for the style of cotton grown. The possibility of ginning by air-blast saw-gins is now being followed up : preliminary tests have been made. The accepted ginning percentage for the price formula is taken at 30·75%. The lint is baled in 400 lb. bales, and in normal times is marketed by the ginnery firms, mainly to India. These firms have few men experienced in grading for cotton quality : most of the cotton is sold on a bulk mark. Prices tend to be rather less for lint from the inland ginneries. There are considerable quality and grade variations from area to area. If it were practicable to grade seed cotton into a few classes at each ginnery, and to aid sales with accepted marks for grade and quality, there might be benefit to the market and an additional return to the grower, as compared with the present system where good and bad generally are ginned together. Under the present ginning arrangements consistency of product is difficult to obtain.

Improved seed from Ukiriguru, when available, will be bulked in a selected area and specially ginned. Then area by area, this improved seed will replace the old. Seed is supplied free to the cultivator from the distribution centres. Transport is probably one of the main expenses involved in strain replacement.

Use of Cotton Seed.

At present little use is made of cotton seed within the Province. The people do not appreciate its value as a protein-rich food for their cattle. Towards the end of the dry season such a protein-rich addition to the poor feed then available would be very valuable. At present there is a Kenya market for cotton seed for dairy feeding in addition to a big demand from the Ministry of Supply.

It has been suggested that, ultimately, oil should be extracted from the cotton seed available, and that some system of returning cotton-seed cake to the growers *pro rata* to the seed-cotton sold should be applied.

Short General Description of Ukiriguru and Lubaga Stations.

It is intended that the cotton work for the Province should be centred on Ukiriguru and that only sub-station work should be continued at Lubaga. Ukiriguru, 900 acres in extent, lies 17 miles from Mwanza and is situated in typical north Sukumaland country—broken granite country with a gently sloping valley below the hill slopes. Under the varied conditions of the Province some compromise in the choice of a station site is necessary, but taking all the factors into consideration a station for cotton work for the Province situated in the Ukiriguru type of country seems about as reasonable a choice as can be made. It is essential, however, that material bred there be tested, and the factors affecting the growing crop be observed, in District Plots scattered through the Province and covering a reasonably wide range of the varied conditions.

Lubaga, 2 miles from Shinyanga township, has about 250 acres under the plough and a large acreage of partly-cleared grazing land. It is an old Lake-bed soil, agriculturally rich, but shallow and sensitive to erosion.

The essential difference between the two stations lies in the shorter cotton season in the south. Primarily climatic, because of a later start and generally earlier finish to the rains, the immediate agricultural reason is that the people plant their sorghum before they plant their cotton, whereas around the Lake shore cotton is among the first of the crops planted ; moreover, stainer attack generally prevents the reaping of an effective late crop in the south.

UKIRIGURU AND LUBAGA EXPERIMENT STATIONS.

PROGRESS REPORT FOR THE SEASON 1944-45

BY

A. N. PRENTICE.

Part I.

Table of Seasonal Data, Etc.

Station.	Planting Period Cotton.	Picking Period.	Legal Uprooting Date.	Rainfall.		Notes.
				Amount.	Distribution.	
Ukiriguru Station 1944–45 ... and vicinity.	Mainly November	Starting April	31st August	28 inches	Bad	Start of rains, planting, picking; up to a month earlier in Island and Lake shore areas.
Generally...	Mainly November	Starting April	31st August	28 inches		
Lubaga 1944–45 ...	Dec. 1944, and Jan. 1945	May to Sept.	15th September	31 inches	Bad—concentrated at end of season.	District cotton, because of food crop priority, is usually planted a month later than on the Station.
Generally...	Dec.–Jan.	Usually only one picking starting May	31st August.	31 inches		

Staff.—Mr. J. E. Peat, who would normally have written the Ukiriguru report, left the station in July to attend Corporation meetings in London. This report, where it deals with Ukiriguru work, draws largely on Mr. Peat's notes, and is perforce often a second-hand record.

Mr. A. M. Pienaar has carried out the duties of Agricultural Assistant on Ukiriguru for the past season.

General Account of the Work of the Season 1944–45.

Agricultural Circumstances.

Weather.—Heavy rains at the very end of the season—giving the wettest May on record in the South—brought the seasonal totals to something like average, 28 inches on Ukiriguru and 31 inches on Lubaga. Distribution, after an early start, was poor. The late rains helped cotton yields considerably, at any rate in the south, where the resultant top crop was able to mature in the absence, for once, of heavy stainer attack. The Provincial crop was just above average at 35,000 bales of lint.

Soils.—The Lubaga experiment with the unpopular hard-pan soil-type " ibambasi " showed the same trend of results as last year. This year (the second) the tie-ridged treatment was again far above " flat " cultivation in yield: tie-ridging, with a yield of 1,100 lb. per acre seed cotton, gave just about double that of the " flat " treatment. (The sorghum section of this experiment showed results of the same type, but here heavy stalk-borer attack interfered badly with the absolute yields of grain). The differences due to manuring were on an altogether lower plane, again agreeing with last year's indications:

differences of the order of 8% over the nil controls. The results so far seem to show that this " neglected because somewhat intractable " soil is fertile enough chemically and needs only water to allow crops to make good use of its inherent fertility—the word " only " may need qualification on deeper analysis, but empirically at any rate, water supply is the limiting factor. Recent seasons have been on the dry side, and it remains to be seen how tie-ridged crops on " ibambasi " can stand water-logging. Even should over-wet seasons be few and far between (as seems possible judging by weather records) there is of course no likelihood that the hand-hoeing cultivator would take at all willingly to this available but hard and hoe-destroying soil-type, in spite of the impetus of land-hunger. In specialised circumstances, however, he should be able to put to use any new knowledge of how to treat " ibambasi " : for example, the Tsetse Research workers in the Province have brought to the state of large-scale trial a method of discriminative clearing of vegetation, in just these " ibambasi " hard-pan soils, for keeping (adjacent) tracts of land free of one local species of tsetse-fly, and should the method work, settlement of these hard-pans may be advisable for the sake of controlling tsetse on other soil-types.

The yields from tie-ridged " ibambasi " of Lubaga stand comparison, this year at any rate, with those from the more favoured soils such as the black loam. In round figures the " ibambasi " was yielding 1,100 lb. seed cotton per acre compared with the 1,000 lb. of the black loam on Lubaga, the 1,180 lb. of the heavy black valley-bottom " mbuga " on Ukiriguru, the 1,100 lb. of the hill-sands on Ukiriguru, and the 800 lb. downwards of a range of soils in the District Plots of the Province (using strain Mz.561 throughout as indicator). Naturally, however, growing influences were not the same throughout.

Agricultural System.

Manuring : Rotation.—The manurial and rotation trials on the Ukiriguru hill-sands showed some reversals of " form " this season, but, over a run of years, there can be no possible doubt of the benefit of organic manuring on at least the lighter soils of Sukumaland. The residual (first year) effect of a 3-tons per acre dressing of F.Y.M. has apparently been to depress yields. Residual (second year) effects are more orthodox, although from a 7-ton dressing of farmyard manure there is the surprisingly high increase of 26% over the control. The first year manurial trial (direct) gave results as anticipated. Mention was made last year (p. 105) of a possible depressing effect on the final cotton crop of the sequence cotton–maize–cotton compared with grain–maize–cotton. There was no indication of this effect being repeated in a comparable trial this season. But in a rotation trial in its second year cotton seemed to have a depressing effect on the immediately following maize crop which was yielding about 26% less than maize following grain. The usual local (and more than local) experience is that grain-after-cotton yields are better than

grain-after-grain yields. Maize is not a good grain crop for measuring manurial responses in years of badly distributed rains, and, though popular as a food crop, is not grown in pure stand by the cultivators. The explanation here probably is that the maize started by growing out better and then was more heavily hit by the drought spells. Millet, or millet with an admixture of sorghum, will be used in future.

At Lubaga, no trend is as yet (third year) evident of a rotational effect of grain on cotton, or of cotton on grain.

Mention was made in last year's Ukiriguru report (p. 105) of the small tonnage of farmyard manure per beast that could be made even with ample bedding—at the best, 3 tons per beast per year. A test was made this season of the amount of compost that could be produced using as much bedding (mainly millet and maize stalks) as would break down. Five oxen, penned at night only, for a period of two months, produced compost at the rate of $17\frac{1}{2}$ tons per beast per year. Bedding wastes, however, are not available to the ordinary cultivator in unlimited quantities.

The response of the Lubaga soils to compost was, as usual, small. A district plot in Shinyanga on a soil-type akin to the Ukiriguru hill-sands, gave the sort of response to manuring—up to a doubling of the yield—which experience in general indicates as likely on the red group of exhausted soils, but unlikely on the black. An " exhaustion acre " at Lubaga, now in its tenth year of continuous cotton, with nothing returned to the land, yielded 470 lb. of seed cotton per acre ; and a similar acre of sorghum, although the grain yield was spoilt by stalk-borer, gave over 2 tons of straw—*i.e.*, passable yields. Comparable figures from the red-soil group are not available, but using the look of the run of native crops in the exhausted, over-cultivated, light-soil areas as some indication, exhaustion here has gone further, and doubtless more quickly, than on the black group.

Two resting-crop trials on the Ukiriguru hill-sands were planted to mixed sorghum-millet as the indicator crop this, the first, cropping season, after the resting treatments had been down for three years. Yields were low, due possibly as much to extraneous reasons, such as stalk-borer and bird damage, as to climatic conditions, which were hard on the grain crops and not favourable to the break-down of dug-in residues this season. In the one trial, the continuous grain control treatment was yielding 520 lb. per acre ; *Hyparrhenia dissoluta* grass dug in was 20% or just significantly better ; *Cynodon* grass was 34% better, Elephant grass 38% better, and Pigeon pea 45% better than the control. In the other trial, with a range of Elephant grass treatments, the control plot of continuous unmanured grain was again the lowest, at 445 lb. per acre ; all the Elephant grass treatments were significantly ahead ($P.=\cdot05$) of the control ; but, on the other hand, all except the one which itself received manure were significantly below continuous grain manured this year.

Grass work.—The *Brachiaria brizantha* mentioned in last year's report (p. 106) seems to be the best of the local grasses at Ukiriguru, and has survived the dry season so far at Lubaga. Many other grasses, mainly locals, but some introductions, are being tried at both stations. A local *Chloris gayana* is promising at Lubaga, where, however, *Cenchrus ciliaris* keeps its lead as quite the most promising grass under observation. Seeding this grass met with very variable results, from failure to complete success; more experience with *Cenchrus* may lead to more consistency in establishing it from seed. It is quite readily established from root divisions, and several acres on Lubaga were planted by this method.*

The grass "*Kavirondo perennial sorghum*" which has had an occasional mention in Lubaga reports, has this season given some disturbing signs of depressing the yield of a following maize-cum-groundnut crop; this mixed crop, where it crossed the site of an old "Kavirondo" plot, was visibly inferior to the crop elsewhere; more evidence on the point should be available next year, when a trial including a "Kavirondo" rest treatment comes under an annual indicator crop.

The stations continue to give such time as is possible to the important problems of grass management; but bare statements are all that can be usefully reported at this stage. Some simple selection within *Cenchrus ciliaris* is being practised at Lubaga, with promising results: *Cenchrus ciliaris* as found around Lubaga seems to be a better agricultural stock or ecotype than *Cenchrus* from other habitats, and selection within this stock has readily isolated a range of forms.

Agricultural Practices.

Tie-ridging.—This practice has long been routine on all except the valley-bottom "mbuga" soils at Ukiriguru, and is now standard practice on all soils at Lubaga. Tie-ridging at Lubaga does not always give a better yield than "flat" cultivation, even in a dry year; this year, for instance, trials on the black loam at Lubaga, using dwarf early-maturing sorghums as the indicator crop,† gave no return for the greater labour of tie-ridging, and tie-ridging in one Shinyanga district plot on sandy soil seemed to cause a marked drop in the yield of cotton. On the other hand, a hard-pan soil experiment (mentioned earlier under Soils) gave a very large increase in yield from tie-ridging. By and large, from evidence accumulated under a range of conditions and from the pooled experience of various Agricultural officers in the Province, it is safe to say that, on the average, tie-ridging leads

*One unforeseen result of having large areas of Elephant Grass—Lubaga has, say, seventy acres of it, and Ukiriguru large blocks—has been that huge flocks of grain-eating birds are afforded sanctuary; the grain-eaters are a really serious pest in the millet and sorghum areas, so that the Elephant grass, which encourages or seems to encourage them, is regarded with disfavour by the native. Elephant grass also harbours animal "vermin."

†A normally late-maturing sorghum would have proved a better indicator for this aspect of the experiment: the results obtained would possibly have been different.

to appreciably better crops than "flat" cultivation; and on that immediate result alone there is every justification for intensive propaganda for tie-ridging in much of the Province. The long-term effect of tie-ridging—its complete check to soil-erosion by water—is fundamentally more important than its effect on current yields. The cumulative effect of erosion with crops on the flat can be expected to tell heavily on crop yields after a few years, and some "flat" *versus* tie-ridging trials are being continued on the same sites for a number of years to test the point, but so far there has been no exact measure of the rate of decline in yield.

Home-made ox-drawn implements for tie-ridging are being tried on Lubaga, with fair success; and one American "basin-lister," a tie-ridging machine meant for tractor draught, has been borrowed to see if it can be adapted for ox-draught.

Miscellaneous.—Tests of the early-maturing sorghums continued on the Stations and in district plots. The dwarf Swaziland types, as might be expected, yield better at relatively close spacings. Under the conditions of the year the white-grained P.41 strain, in spite of its fault of lodging, was the heaviest yielder of the three Swazilands. The variety Dobbs, somewhat later than the Swazilands but still in the early class and yet reasonably vigorous, did very well on both Stations. Newer, and possibly better, introductions are being watched.

Cotton Breeding.

Cotton yields were high on the whole this year. The growing season was extended by good late rains, and pests, notably stainers, were less destructive than usual.

Two of the new Barberton crosses, A.2120 (of the U.4/5143× Cambodia group) and A.2195 (U.4/8161×MU8A), came under close scrutiny. They were included in three balanced incomplete block trials* of 25 strains×6 replications, one on the Ukiriguru hill-sands, the other two scattered over district plots ranging from as far north as Ukerewe Island to as far south as Lubaga. The season was one of fairly light jassid attack, so that the highly jassid-resistant types such as A.2120 and MU8A were never fully extended. A medium degree of jassid-resistance was good enough for safety this season especially under trial conditions. Some representative yields from these three trials are picked out to set against A.2120 and A.2195 :—

Ukiriguru Trial.			*District Trial A.*			*District Trial B.*		
Strain.	*Position.*	*lb. per acre Lint.*	*Strain.*	*Position.*	*lb. per acre Lint.*	*Strain.*	*Position.*	*lb. per acre Lint.*
A.2195	1st	390	MU8A	1st	301	MU8A	1st	242
3/33	2nd	384	2/62...	2nd	284	2/301	2nd	219
A.2120	5th	373	A.2120	5th	265	A.2120	3rd	217
MU8A	6th	372	Mz.Local	8th	251	A.2195	11th	192
Mz.561	11th	353	A.2195	11th	242	Mz.Local	19th	175
Mz.Local	12th	351	Mz.561	19th	226	Mz.561	20th	171
(Worst Strain)	25th	300	(Worst)	25th	195	(Worst)	25th	147
L.S.D. (P=·05)		29	L.S.D. (P=·05)		44	L.S.D. (not yet tested)		

*Barberton's help (especially that of Mr. H. E. King), with the technicalities of these trials is gratefully acknowledged.

A.2120 and A.2195 thus put up a very creditable performance, and can be expected to do relatively better in a year of heavy jassid. The standard of hairiness of the local selections from the Mwanza and other stocks now at the testing stage is steadily rising however. Second places in the three trials of the table above, and in a trial on the Ukiriguru " mbuga " are taken by derivatives of Mz.561, Mz. Local, a Gatooma U.4 × Cambodia cross, and Mz.457 respectively. A fault of A.2120 is its lateness, a fault which as it happened did not matter this year, but could be serious in some years, especially in the south of the Province where the season is often curtailed by stainer attack. A.2120 has vigour—very desirable on the played-out soils—large bolls, and seemingly good lint quality, in addition to its first-class jassid-resistance. A.2195 is an earlier plant but less vigorous, and with jassid-resistance and lint quality, though still far from unsatisfactory, seemingly somewhat below A.2120. The only other of the new Barberton crosses in trials, A.150, was down at the level of Mz.561 in yield.

There was a comment in last year's Ukiriguru report (p. 107) to the effect that breeding for yield improvement for difficult conditions was simpler than breeding for easy conditions. Conditions were fairly " easy " this year. From the Table above it can be seen that there was little difference in yield between Mz.561 and Mz. Local. At Lubaga, where conditions were markedly easier than usual for the cotton plant, Mz. Local was generally level with Mz.561 in trials, although in most years Mz.561 would be much the better yielder. In a trial on the heavy black bottom land (or " mbuga ") at Ukiriguru, Mz.561 and Local were yielding alike at 376 lb. lint per acre ; MU8A in this trial was significantly heavier with the good yield of 493 lb. lint per acre, but this 30% increase is small beside the increase over Mz.561 (50%) and over Local (100%) reported under last year's " mbuga " trial, when jassid damage was heavy.

A number of Parnell's U.4 × Sea Island crosses was also grown, in observation plots. On soil of mediocre fertility, many of these " quality " crosses, as they stand, show insufficient hairiness for the conditions, but all are being carried forward again after mass selection. For general field qualities A.3313/1 seems the best of those tried. Vigour is rather lacking in the group as a whole. Lint quality in this group of crosses is, of course, in a higher class than in the run of the material on Ukiriguru.

Cotton Pests and Diseases.

Jassid.—The attack, although variable, was not heavy enough in most areas to affect the stock strain of Sukumaland, Mz.561. Mz.561 is only fair for jassid-resistance, and the jassid attack for the season can therefore be summarised as light. However, conditions giving rise to poor growth were enough to tip the balance in favour of jassid (doubtless through a shortening of leaf hairs), and cotton on badly played-out soils did suffer jassid damage this year.

Stainers.—Dysdercus attack was unusually light, and late in getting going—probably throughout Sukumaland, and certainly in the south. In the south, the drop from the usual numbers was most noticeable in *D. fasciatus*, the most important species. *Calidea* stainers were scarce in most areas and indeed absent altogether on Lubaga, but were locally numerous for short periods in some northern areas. Reasons for the lack of stainers are not known.

The light attack, coupled with good late rains, allowed the Lubaga cotton to mature its heaviest crop for many years, and served by contrast to emphasise the importance of stainer attack in limiting yields in most years. Yields well over the 1,000 lb. per acre (seed cotton) mark were commonly recorded, such yields over large acreages being exceptional on Lubaga. The proportion of Grade C cotton did eventually reach 25%, and more in some plots, but even this is light staining by Lubaga standards and was mostly accounted for by late-season staining in patches on the farm. The bulk of the Lubaga cotton showed 10% or less Grade C this season. A district plot was opened in an area (Kahama) in the adjacent Province where the history of cotton-growing is one of failure due largely to insect pests. The plot was started in the hope that a really massive attack by stainers would develop and provide a severe test for poisoning methods of control; but although various species* were present, stainers did not appear in appreciable numbers all the season, and the yield over the whole plot was at the good rate of 1,150 lb. clean seed cotton per acre. (MU8A was used in this plot, to avoid possible complications with jassid.)

A large and elaborate stainer-poisoning trial on Lubaga showed, for what the results are worth in this season of light and atypical attack, that a light intensity of poisoning (fortnightly, starting late in the season) gave better results than heavier intensities (such as weekly, starting early). Poisoning did not noticeably increase yields this season—and could on occasion actually lower yields, possibly due to damage by the extra trampling in poisoned compared with control plots. Poisoning, however, always improved the grade of seed cotton whether staining was naturally at a low or at a fairly high level. There was little difference between close- and wide-spaced cotton in degree of staining or in reaction to poisoning, but late-planted cotton benefited relatively more than early from poisoning.

At Ukiriguru the trial on the hill-sands gave about 18% Grade C cotton, and the "mbuga" strain trial 22%—fairly high figures for Ukiriguru. A stainer-poisoning experiment was carried out on six pairs of plots in an "mbuga" trial where plant growth is better. The six poisoned plots averaged 872 lb. per acre seed cotton of which 12% was stained; while the corresponding figures for the control plots were 732 lb. and 20% stained. The poisoning was of appreciable use.

**Dysdercus intermedius* was found as well as the usual Lake Province species. *Helopeltis* (*thævora ?*) was present. The identifications were made by Mr. E. O. Pearson or Mr. V. Harris, both of whom saw this plot.

Other Pests.—American bollworm, *Heliothis armigera,* was occasionally serious under District Plot or station conditions, doubtless influenced by early maize, and by pigeon-pea blocks. One district plot (Mabuki) on heavy soil, about 20 miles south of Ukiriguru, had not only a severe American bollworm attack, but had also one of the few severe (but short) *Calidea* attacks of the year. This plot at one stage seemed ruined, but finally yielded 950 lb. per acre seed cotton—indicative of the powers of recovery of cotton when given an extended growing season.

Lygus was not troublesome at Ukiriguru except in a moderate degree on the valley-bottom " mbuga " soils. *Lygus* is generally regarded at Ukiriguru as an " mbuga " pest, in contrast to aphis, a pest of cotton on the hill-sands.

Diseases.—Bacterium malvacearum in the Blackarm stage seemed to be doing damage to district cotton in the poorer soils around Ukiriguru. At Lubaga there was undoubtedly a fair amount of bacterial boll-rot in March–April, on one part of the station ; the absence of the usual heavy staining may have brought the presence of other boll-rots more to notice. Blackarm was rare on Lubaga, as was angular leaf-spot, but a blackening of leaf-veins was seen occasionally. *Alternaria* was troublesome in patches on Lubaga, and one or two heavy attacks of this leaf disease were seen on district cotton in Shinyanga.

Part II.

There are no detailed experiments this year that call for detailed report in Part II.

PROGRAMME OF WORK FOR SEASON 1945-46.

Ukiriguru.

Agricultural System.—A new resting crop and manurial trial will include in its treatments, raw rock phosphate at 400 lb. per acre, a 3-year fallow planted to a mixture of the best local grasses, and a plain (tumbledown) fallow.

The other manurial, resting and rotation trials, and the grass work continue. The district plots are to be put on a grass-rotation system as far as feasible.

Cotton.—All strain trials, including those in district plots, will be " interlarded " with the jassid-susceptible Mz. Local in an attempt to breed up jassid populations within the trials : at present it seems likely that the less resistant strains in a trial are afforded undue protection by their neighbours.

Pests and Diseases.—A number of strains from Mr. Jameson (Uganda) will be tested for jassid-resistance.

Mr. Jameson has kindly supplied a set of susceptible and resistant types for observations on Blackarm.

To test the effect of soil-fertility on the expression of hairiness, plants of a given strain will be grown under as poor and as rich conditions as possible. The material will be sent to Barberton—whence this experiment originated—for examination.

General.—Other work as usual.

Lubaga.

The experimental work is likely to continue at Lubaga for another season, on the same lines as before ; eventually some sections of the work will be transferred to Ukiriguru.

Agricultural System.—The two grass resting treatments in a continuous *versus* discontinuous cultivation experiment are due to come under annual crop this season.

All aspects of the grass work continue to expand.

Cotton.—Strain trials are dovetailed with those of Ukiriguru. A full breeding programme will be carried out, but this is likely to be the last season of intensive selection work before the shift to Ukiriguru.

Pests and Diseases.—Poisoning trials against stainers will be continued with sodium arsenite, and will be extended if possible to include tartar emetic, which in preliminary cage-tests this year promised well.

Should D.D.T. be available, field scale tests against stainers will be carried out in conjunction with Mr. Harris.

The malvaceous collection will be kept going in small plots ; conceivably some host-plant might be useful as a trap-crop against stainers.

Potash, if available, will be tried for its effect on *Alternaria* (*c.f.* recent Barberton experience).

EASTERN PROVINCE.

PROGRESS REPORT FOR 1944

BY

A. G. BEBBINGTON AND A. H. McKINSTRY.

Planting period	Mid-February to mid-April.
Picking	August to October.
Uprooting	Latter half of November.

INTRODUCTION.

The present report covers the work on the main site at Ilonga and on the district plots, six in number. All these were on the same sites as last year with one exception. The plot at Mvomero was abandoned and replaced by another, six miles to the west of Mvomero on a similar type of soil, at Mkundi.

The soils of most of the district plots had been cropped continuously for many years before being put to their present use. Resting under a grass cover is definitely needed in some cases. This practice is being borne in mind in the planning of future experiments in these plots.

The acreage finally cleared and planted to cotton at Ilonga was forty-five.

WEATHER.

The season was a difficult one. The short rains did not break until the beginning of January at Ilonga and later in the month on the district plots. After a short rainy period of about fourteen days there followed a drought lasting until the middle of March. Very heavy rains then fell during the latter part of March, in April and the early part of May on most plots. At Ilonga a total of 30 inches fell in 65 days. In contrast rainfall at Kingolwira Farm was only about half this amount.

AGRICULTURE.

This year the planting of grain and pulse crops rather than cotton was emphasised as being the agricultural policy necessary to the war effort. Planting ot these crops was carried out in January, but the drought in February and March, coupled with widespread outbreaks of armyworm, caused serious damage. As a result, when the long rains started in March much replanting was necessary ; this further reduced the cotton acreage and also led to very late planting in April. Heavy attacks of American bollworm followed in June and July and serious crop loss occurred. As a result of this combination of circumstances the cotton crop of the Province was the lowest for many years.

Planting at Ilonga and on the district plots was carried out between the 13th and 24th March in good conditions. Acid-treated seed was used and excellent plant stands were obtained throughout.

Experimental Work.—Two spacing-cum-plant-density trials were laid down at Ilonga and Mkundi. These indicated as previously that the safest spacing is 3 feet by 3 feet with two plants to the hill.

Cotton Breeding Work.

The testing of different varieties and strains, particularly with regard to their reaction to insect pest attack, was continued.

The variety trial of the previous season was continued in slightly modified form in all plots. The varieties used were the types forming the commercial crops of Buganda (B.P.52), the Lake Province of Tanganyika (Mz.561), Eastern Province Local, a Kingolwira selection (553), and M.U.8, a strain of Malwa Upland. The latter was included again on account of its early maturity and prolific flowering. Planting everywhere was carried out at roughly the same time in randomised blocks with six replications. Very good plant stands were obtained. The yields are given in the following table :—

Table of Yields per acre in Variety Trials from Ilonga and District Plots, 1944.

Strain	*M.U.8.*		*Local.*		*B.P.52.*		*K.553.*		*Mz.561.*	
Ginning percentage (Grade I only)	*33·8%*		*31·1%*		*33·4%*		*31·0%*		*32·5%*	
	Seed Cotton.	*Lint.*	*Seed Cotton.*	*Lint.*	*Seed Cotton.*	*Lint.*	*Seed Cotton.*	*Lint.*	*Seed Cotton.*	*Lint.*
	lb.	*lb.*	*lb.*	*lb.*	*lb.*	*lb.*	*lb.*	*lb.*	*lb.*	*lb.*
Ilonga	488	165	354	110	444	148	386	120	390	127
Kwa Dihombo	792	263	536	166	450	151	515	160	503	164
Mkundi	437	147	322	100	379	127	437	136	359	117
Morogoro	1,097	370	741	230	778	257	807	250	894	290
Mgera	651	220	571	177	496	166	658	204	553	180
Kingolwira Village	249	84	174	54	183	61	247	77	247	80
Kingolwira Farm	202	68	203	63	—	—	337	105	296	96

According to soil conditions the plots may be classified as follows : (i) Alluvial soils.—Ilonga, Kwa Dihombo, Mkundi ; (ii) Intermediate.—Kingolwira Village, Mgera, Morogoro ; (iii) Dry.—Kingolwira Farm.

The trials at Ilonga, Kingolwira Farm and Kingolwira Village were heavily attacked by American bollworm. A medium attack occurred at Mkundi, while Morogoro, Kwa Dihombo and Mgera experienced comparatively mild attacks. The effect of these attacks on the trials and in particular on plant development is discussed under American bollworm. With the exception of the trial at Kingolwira Farm, M.U.8 maintained its leading position. The differences in yield of this variety over Local were statistically significant in the case of Morogoro and Kwa Dihombo. The superiority in yield of K.553 over Local did not show up as well as in previous seasons. One disappointing feature of the trial was the performance of the Uganda B.P.52 which cannot be said to be any better in yield than Local. The high quality of the lint was maintained, however, according to a report on a sample

sent to a commercial firm in Uganda. It commands a premium over Eastern Province Local lint. The quality of Mz.561 lint is not equal to that of Local.

Strain Trials.—A trial of eight strains originally selected from Local at Kingolwira some years ago was planted in each of the plots with Local as the control. The results from the point of view of yield were somewhat conflicting. It was, however, possible on general behaviour to discard five of them. The remaining three will be tested again. They are not likely substitutes for Local as they are only slightly better in yield, while both lint quality and ginning percentage are doubtful.

Single Plants.—The re-selections taken at Ilonga in 1943 were carried forward. These were all originally taken from Local. While there is some promising material in them, there is a tendency for lint quality and ginning percentage to drop in the higher-yielding types. Better quality lint also tends to be associated with lower-yielding types. A number of re-selections and fresh selections were made.

Importations.—Twenty varieties and strains, seed of which was obtained from the Senior Botanist, Uganda, were planted at Ilonga. Of these, ten were discarded on account of poor jassid-resistance and for various other reasons.

A number of Barberton Cambodia × U.4 crosses were grown. These showed great cropping ability, but the lint quality was not up to the standard of Local.

Insect Pests.

Continuous records of the main pests were taken throughout the season in the variety trials on all plots in conjunction with plant development records. The mature crop was analysed for bollworm and stainer damage.

Jassid (Empoasca spp.).—This pest was observed in much larger numbers than usual in the early part of the season. It was particularly in evidence at Kingolwira Village where it undoubtedly affected the early flowering. Nymphal counts showed the largest populations on Local, K.553 and Mz.561. Elsewhere, although present in some numbers, it cannot be said to have been of any real importance. So far as present experience goes, only a small degree of jassid-resistance appears necessary for the Eastern Province.

American Bollworm (Heliothis armigera).—While all plots were affected to some extent the largest larval populations were recorded at Ilonga, Kingolwira Village and Kingolwira Farm, the peak population at Ilonga being five times as great as in 1943. The attack in most plots was spread over a much longer period, nine weeks at Ilonga comparing with four in the previous season. At Mkundi, larvæ were recorded from May to September.

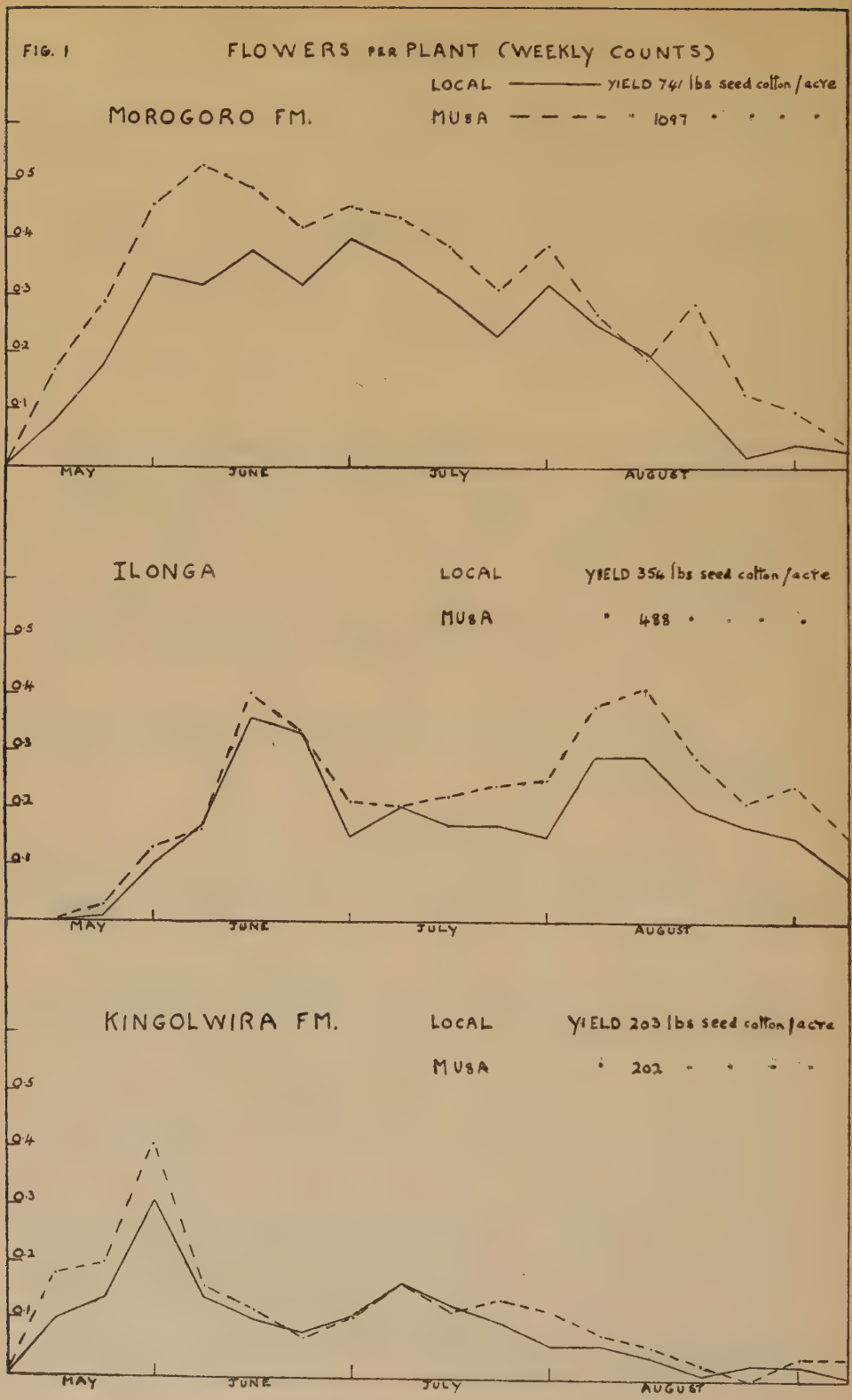
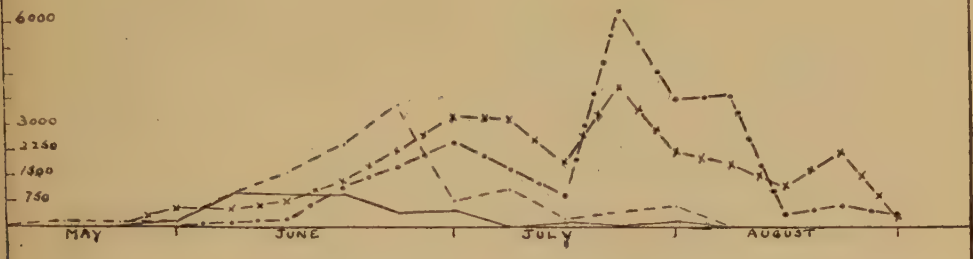


FIG. 1
FLOWERS PER PLANT (WEEKLY COUNTS)
LOCAL ——— YIELD 741 lbs seed cotton/acre
MUSA — — — — 1097
MOROGORO FM.
0·5
0·4
0·3
0·2
0·1
MAY
JUNE
JULY
AUGUST
ILONGA
LOCAL YIELD 354 lbs seed cotton/acre
MUSA 488
0·5
0·4
0·3
0·2
0·1
MAY
JUNE
JULY
AUGUST
KINGOLWIRA FM.
LOCAL YIELD 203 lbs seed cotton/acre
MUSA 202
0·5
0·4
0·3
0·2
0·1
MAY
JUNE
JULY
AUGUST

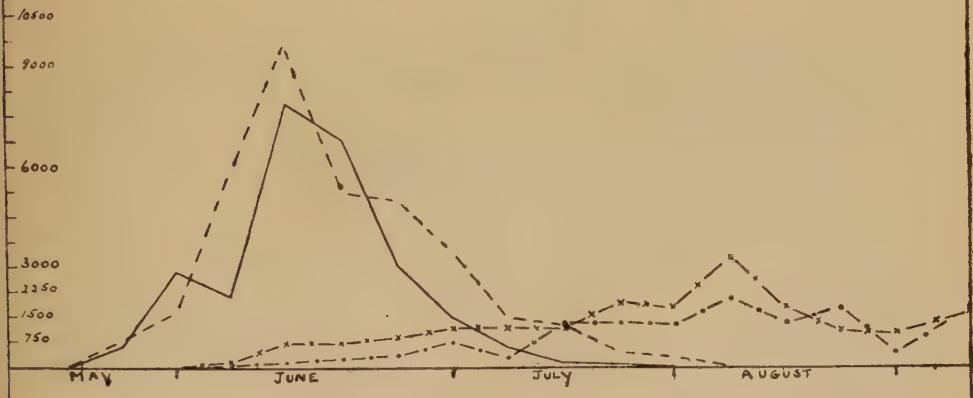
FIG. 2 AMERICAN BOLLWORM LARVAE AND ADULT STAINERS PER ACRE

LOCAL BOLLWORM LARVAE ———
MUSA " " — — — —
LOCAL ADULT STAINERS —•—•—•—
MUSA " " —x—x—x—

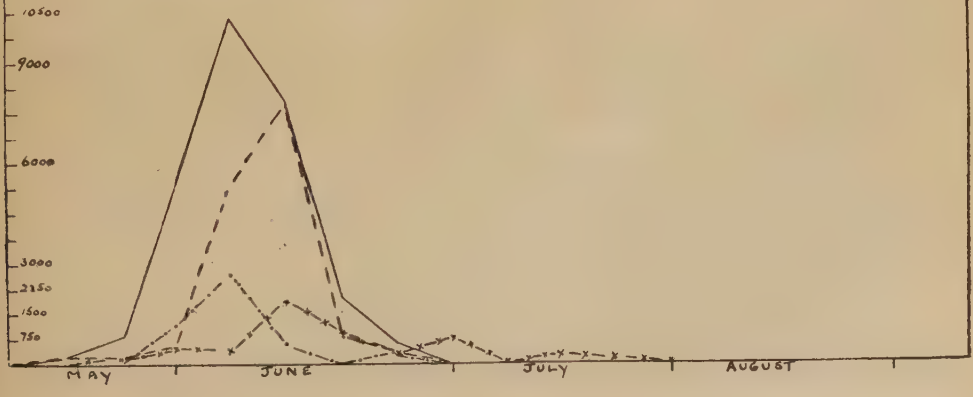
MOROGORO FM.



ILONGA



KINGOLWIRA FM.



The attack started as usual at the commencement of flowering and attained its maximum intensity in June and July.

The flowering curves and distribution of larval populations are shown for M.U.8A and Local, in Figures 1 and 2, for Ilonga, Morogoro and Kingolwira Farm. At Morogoro where the attack was comparatively mild a more or less normal flowering curve resulted, but flowering at Ilonga and Kingolwira Farm was seriously affected and the result is shown in the final yields. The figures also illustrate the possibility of recovery to some extent under the better growing conditions of the alluvial soils. The flowering curve for Ilonga shows a rise immediately the larval population dropped and eventually reached the same peak as prior to the attack. While there was some attempt to recover at Kingolwira, growing conditions were such as to preclude any great increase in flowering. In spite of the fact that the total number of larvæ recorded on identical samples was considerably higher at Ilonga, the final yields of Local were, at Ilonga, 354 lb. seed cotton (110 lb. lint) per acre, and at Kingolwira 203 lb. (63 lb. lint).

The larval records in the Variety Trials showed, in four out of the seven, a much higher population on M.U.8 than on Local. The following table gives the total larvæ recorded in each variety at each plot during the season :—

TABLE OF AMERICAN BOLLWORM LARVÆ RECORDED DURING THE SEASON ON 30 PLANTS HILLS OF EACH VARIETY.

Place.	*M.U.8.*	*Local.*	*K.553.*	*Mz.561.*	*B.P.52.*
Ilonga	218*	154	172	156	160
Kwa Dihombo	36	29	36	33	24
Mkundi	115*	63	67	73	50
Morogoro	78*	27	22	33	29
Mgera	79	87	79	72	61
Kingolwira Village	184*	125	138	115	142
Kingolwira Farm	94	141	108	107	—

In the four trials marked with an asterisk the differences in the total larval populations recorded on M.U.8 and Local were found to be significant when tested on a method given by Mr. E. O. Peason. In view of these figures it is surprising that M.U.8 should have maintained its leading position to the extent to which it did. At Morogoro where the final yield of M.U.8 was significantly better than Local by 356 lb. seed cotton (140 lb. lint) per acre, the relative larval populations at the peak were M.U.8, 3,700 per acre and Local 900.

Shedding.—Mass collections of shed buds were undertaken on the district plots. These showed that from 85–90 per cent. of those shed at Kingolwira Farm were caused by bollworm during June. Elsewhere the figure varied from 60–80 per cent.

At Ilonga all flowers on a hundred plants chosen in an early-planted bulk of Local were tagged. All sheds were collected and analysed for damage as were also the final open bolls.

The figures were :—

Total flowers set	5,150
Total flowers and bolls shed	2,778

Of this total shed 50·5 per cent. was due to bollworm.

The mature bolls were examined lock by lock, damage being classified into :—(i) Completely destroyed by bollworm ; (ii) completely destroyed by stainers ; (iii) Grade III cotton due to stainer and bollworm ; (iv) Grade I cotton.

Including the shed flowers and bolls the final figures are as follows. They are given as percentages of the total flowers tagged.

Grade I cotton	27·8
Total loss due to bollworm	28·0
Total loss due to stainer	15·1
Total loss due to other causes	14·4
Grade III cotton	8·2
Unaccounted for	6·5
	100·0

In 1943 comparison of early- and late-planted crops, that is to say, March and April, seemed to suggest that the later-planted evaded American bollworm to some extent. To obtain more information on this point plots of Local were planted early—middle of March, and late—middle of April, in all district plots. These were not replicated or arranged in any randomised manner owing to the difficulties encountered in this type of layout on account of the movement of insects from one plot to another. While then the final results are not capable of statistical analysis there is overwhelming evidence in favour of the earlier planting. In no case did the yields of the later plantings approach those of the earlier. While it was not possible to record insect pests on the different plantings in the district plots, this was carried out at Ilonga on two plots planted on March 14th and April 10th respectively. Mature bolls from random samples constituting 10 per cent. of one acre were picked weekly and examined lock by lock for damage as in the case of the tagged flowers.

The insect records showed that the American bollworm population was much smaller on the later planting, a peak of 1,750 larvæ per acre comparing with just on 4,000. This peak population was recorded, however, just as the less well developed plants were beginning to flower and it must have had proportionately a much greater effect. Unfortunately shedding records could not be undertaken. Flowering throughout the cropping season never attained even half the rate of that on the early plants. The final analysis of the two crops is shown in Figure 3. It shows the percentages of the total locks picked which were damaged or healthy week by week. The final yields were 608 lb. and 136 lb. seed cotton per acre (189 lb. and 41 lb. lint) respectively. In spite of the smaller crop set by the late plantings this did not save

ANALYSIS OF MATURE CROP (WEEKLY PICKINGS)

ILONGA. LOCAL. PLANTED 14.3.44. YIELD. 608 lbs seed cotton/acre

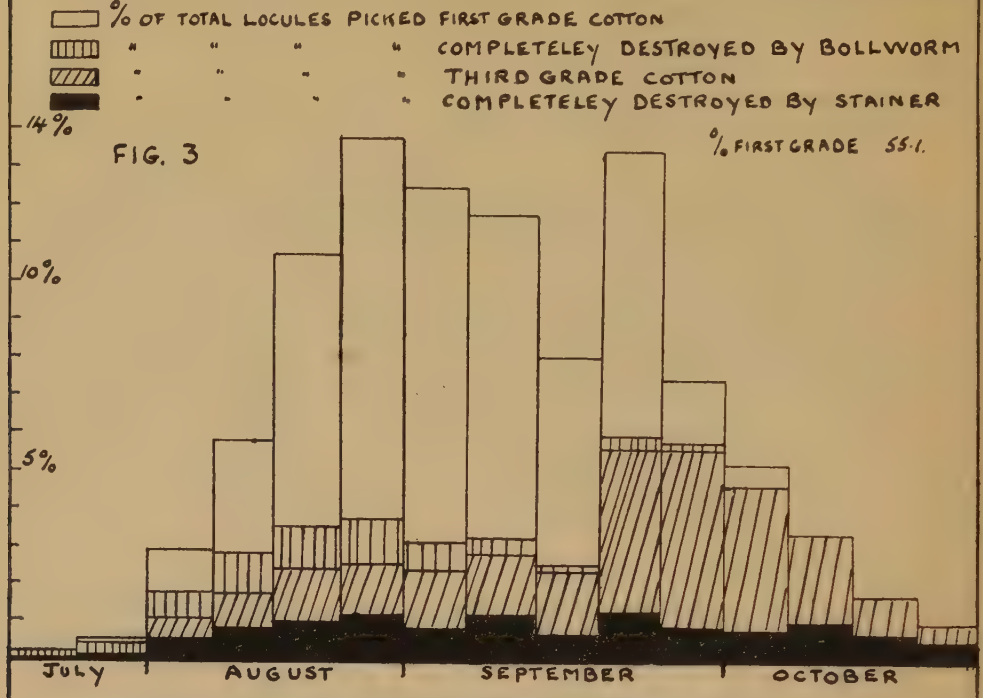
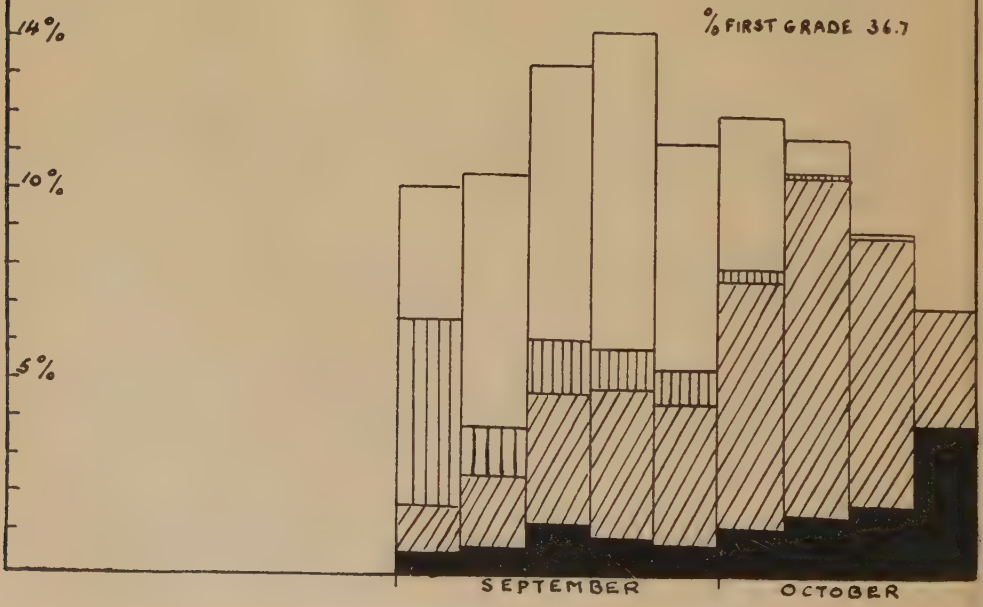


FIG. 3

ILONGA. LOCAL. PLANTED 10.4.44 YIELD 136 lbs seed cotton/acre



it from serious stainer attack. Of the yields obtained, 55 per cent. of the early crop was Grade I cotton, while only 37 per cent. was Grade I in the case of the later. These figures give an indication as to why the crop of the Eastern Province was so low this year. Most of the native cotton, owing to the nature of the season, was planted round about the date of the later planting at Ilonga or even later. It may be imagined what some of their yields must have been.

Pink Bollworm (Platyedra gossypiella).—This was recorded in small numbers during the later part of the season, showing the usual tendency to build up a population. The close season measures are undoubtedly essential to hold this pest in check. In this connection the futility of postponing the uprooting date in order to obtain more crop is well demonstrated by the analyses carried out on the early- and late-planted crops (Fig. 3). 12 per cent. of the total crop of the early-planted cotton was picked in October, of which a negligible amount was Grade I. Of the 41 per cent. of the total crop of the later-planted picked in October, only 5 per cent. was Grade I. The negligible gain in yield is therefore not to be considered when compared with the potential loss to be caused to succeeding crops by the breeding up of pink bollworm owing to delayed uprooting and burning.

Spiny Bollworm (Earias spp.).—This was present throughout the season in all plots, sometimes in considerable numbers. The damage caused by it cannot be compared with that caused by American bollworm to the main crop. It is, however, yet another factor in reducing yields.

Stainers (Dysdercus spp.).—The same four species were recorded as previously, *D. intermedius*, *D. fasciatus*, *D. nigrofasciatus* and *D. cardinalis*. With the exception of Ilonga and Kingolwira Farm where stainer population was undoubtedly affected by bollworm damage, particularly in the latter case, larger numbers of stainers were recorded than in the previous season. The distribution of total adults is given for M.U.8 and Local at Ilonga, Kingolwira Farm and Morogoro in Fig. 2. It may be noted that M.U.8 carried considerably larger populations than Local.

The most numerous species in all plots was *D. intermedius*, the attack beginning shortly after commencement of flowering and rising to a peak shortly after the end of the bollworm attack. *D. fasciatus* was observed in numbers towards the end of the season. *D. nigrofasciatus* was present throughout, particularly at Ilonga and Kingolwira Village. *D. cardinalis* was only recorded in small numbers.

It was not possible to continue further investigation into the stainer attack on very early-planted cotton as none was planted in February this year.

Calidea spp.—This pest was observed in varying numbers in all plots. It could not be said to be serious anywhere.

Helopeltis spp.—This was only taken in any numbers at Ilonga where a peak population of 670 per acre was recorded in July. Much more surface damage to bolls was observed than in 1943.

Capsid (Lygus spp.).—No examples of the very marked damage such as that caused at Kingolwira Village last year were seen. In some of the plots signs of damage were common towards the end of the season on the later-planted cotton.

Summary.

So far as our present knowledge goes the insect pest-plant relationship would appear to be as follows. The cotton plant has to make its *main* crop in the face of heavy attacks by two major insect pests, American bollworm and cotton stainers. These, of course, vary in intensity from year to year. There would not appear to be any possibility of evading them by later planting. Although growing conditions are such in most areas as to make it possible for the plants to set more crop, continuing stainer attack, pink bollworm, spiny bollworm and Capsids all tend to cause increasing loss of crop as the season progresses.

The evidence supplied by the behaviour of M.U.8 in the past two seasons makes it obvious that a much more prolific type than Local is required if yields are to be improved. The ability of M.U.8 to yield more, even when experiencing heavier pest attack, is good proof of this. It remains to be seen whether such a type can be obtained with lint quality equal to that of Local.

The value of district plots in obtaining this picture of the insect-plant relationship cannot be over emphasised. It would have been impossible to obtain in so short a time had the work been restricted to one place.

PROGRAMME OF EXPERIMENTAL WORK, 1945.

The insect and plant development records will be carried on. Further varieties and strains will be tested. Selection work will be carried out in so far as is possible.

NOTES ON THE SEASON 1945.

The rains began early in November, 1944, and continued through the next two months. This resulted in the native having difficulty in clearing his gardens of weed growth. In spite of this, there was a very considerable increase in the acreage of cotton planted. Owing to a combination of reasons, the crop for the Province will, however, be even smaller than in the season 1944. Rainfall was

excessive in most of the alluvial areas during April and early May and tended to retard growth. The areas normally drier and more unsuitable, have all given better yields than for many years. Insect pests have been responsible to a very large extent for the fall in production. Many of the early-planted crops were very seriously attacked by *Helopeltis*, the plants being completely destroyed in many cases. Stainers (*Dysdercus* spp.) also caused a great deal of damage.

American bollworm (*Heliothis armigera*) did not cause such widespread damage as in past seasons. Pink bollworm was observed in numbers at the commencement of flowering. This is thought to be due to re-growth of cotton plants, which had not been properly cut out. This re-growth was encouraged by the ample rains in November and December, 1944. The uprooting and burning date for the present year has been advanced by one month in order to increase the period of the close season.

Experimental Work.

The insect and plant development records have been continued at Ilonga and on the district plots. Stainers and *Helopeltis* have been the most prominent pests. The extent of damage caused may be demonstrated by the fact that two out of the six district plots will give little or no yield at all, while the proportion of stained cotton in the others will be very high. Final results of the variety and strain trials are not yet available. Selection work on derivatives of the Local commercial seed has been continued and also on the Sea Island × U.4. crosses, seed of which was supplied from Barberton.

NYASALAND

COTTON EXPERIMENT STATIONS

Introductory Note

BY

H. C. DUCKER.

District.	*Elevation.*	*Types of Crop.*	*Months in which:*		*Legal Close Season.*
			Sown.	*Harvested.*	
Lower Shire } Lower River ...	200–500	{ Semi-summer Winter	Jan.–Feb. Mar.–Apr.	July–Oct. Sept.–Oct.	} Nov.–Dec.
Central Areas	1,000–2,500	{ Semi-summer Summer	Jan. Nov.–Dec.	July–Sept. May–Aug.	} Oct.–Nov.
North Nyasa : Karonga Lake shore areas only	1,600	Winter	Mar.–May	Sept.–Dec.	Jan.–Feb.

Close seasons in Nyasaland will probably be modified in future to accord with the entomological findings, when Government has decided what action to take with regard to the Lower River areas.

In commencing the 1943/44 report it was said that the general agricultural circumstances and policy of the country had remained unchanged. The same is true of 1944/45, but the end of the war may see some improvement in the status of cotton as an economic crop.

The factors militating against cotton-growing in the Central Areas have continued unchecked during the year under review and there has been a further drop in production in these areas. With, however, the urge to export, now that the conclusion of hostilities has opened the way to a diminution of shipping difficulties, it is hoped that a " more crops " campaign recently begun by Government may reverse this trend, and enable our summer crop areas to come into their own.

The winter crop in N. Nyasa continues to give good results and only awaits development of possible irrigation facilities to achieve its full possibilities.

While it has not been thought worth while to recommence formal experimental work in this area, a commercial trial of N.17 cotton has been arranged on private land near Vua, and an observation plot of B.P.52 cotton has been planted near Karonga. Both are good staple cottons of the old Nyasaland Upland type as re-selected in Uganda, and the former has previously given good results in a strain trial at Vua.

Work on the problems of summer crop cotton continues at Domira Bay and some useful results may be claimed. Two cotton varieties, Mz.561 from Tanganyika and C.L.20, locally selected from Nyasaland Crown Land commercial bulk, are now undergoing commercial trial in the Central Areas.

The work of the Insect Pest Control Section on our major pest, Red bollworm (*Diparopsis castanea* Hamps.) has been concluded and a report on it by Mr. Pearson and Mr. Mitchell was presented to the Nyasaland Government in April, 1945. This report was published by Government in July, 1945, and a summary taken from it, which could not be prepared in time for the 1943/44 Reports from Experiment Stations, is included in Part II of the present report, together with a foreword by Government, prepared after detailed discussions held with Mr. Pearson.

The report proposes one of two possible cotton-growing techniques :—(*a*) Floodland or irrigated cotton, planted in mid-April, at the end of the rains, *i.e.*, a late-planted winter crop similar to that successfully grown in North Nyasa,

or

(*b*) Dryland, rain-grown cotton, planted in December, early in the rains, *i.e.*, an early-planted summer crop similar to that of the Central Areas of Nyasaland, but uprooted not later than July 31st. This is the normal practice at the Domira Bay Station.

A non-cotton year has also been recommended as a necessary preliminary to the introduction of the second method of cropping.

These two regimes are mutually exclusive, and the research work now concluded has demonstrated clearly that the idea of a compromise between them, called semi-summer cropping by the writer, is incompatible with control of our major pest. Cotton-growing technique in the principal cotton area of Nyasaland has therefore been clearly defined by the entomologists, and the way lies open for positive direction of the African grower, on whichever line is selected by Government.

Mr. Mitchell has now left the Corporation and Mr. Pearson's headquarters have been transferred to Uganda. Mr. S. T. Hoyle, who has acted as Agricultural Officer, Ncheu, during the war has continued in his secondment to Government and will do so till the end of the current year. Next season, after a short leave, he will be returning to Corporation work at Domira Bay.

DOMIRA BAY STATION

PROGRESS REPORT, 1944-45

Part I.

BY

H. C. DUCKER AND W. L. MILLER.

General Survey of the Season and of the Experimental Work ; and Conclusions.

Meteorology.

The total rainfall for the season was 46·08 inches, the highest total to date at this station.

Distribution was generally good and the rains began very early, planting of food crops being in full swing by mid-November, a full month earlier than is usual.

Dull weather and continuous rain in January and February caused some concern, but the good start to the season and favourable conditions in March and April obviated any possible ill effects. Crops in general did well and the Domira Bay area has made a good recovery from the drought year of 1943/44.

Agriculture.

Four high yielding derivatives from Mz.561, and the Crown Land U.4, bulk derivative C.L.20, were used as the main bulk cottons on the station this season. Yields were good having regard to the fertility status of the lands in use, the mean yield from the Mz.561 lots being 615 lb. seed cotton (190 lb. lint) per acre from 20 acres. Certain of the C.L.20 plots gave over 1,000 lb. seed cotton (340 lb. lint) per acre, and their general average was at least as good as that of the Mz.561. In contradistinction to the good performance of Mz.561 on the Station, in the Sharpevale district strain trial it was significantly outyielded by U.4 commercial bulk. In this trial all plots were planted with the very first rain and growth was very large. The less rampant Mz.561 was probably at a disadvantage, since competition in the two row plots used must have been considerable. On the station, advantage was taken of the early break of the rains to establish food crops and then clean the first weed growth from all fields before planting cotton. The latter therefore went in at about its normal time in December, and made more normal growth.

As in 1943/44 tagging of flowers was done in a random series of plots of Mz.561. This year, however, the plots were duplicated in two fields, one of which was old land (F.31) the other new clearing (F.57). No account was taken of total square formation or square shedding losses, but total flower production from ten random plots per field (each 5 perfect holes × three plants) was recorded by the taggings.

The summarised results follow hereunder :—

Analysis of Tagging Totals.

Field 31. All Plots.		
Total Flowers as shown by taggings	4,866	100%
Total sheddings due to Bollworm	1,050	21·6%
Total sheddings, non-Bollworm	2,581	53·0%
Total Ripe Bolls produced	1,018	21·0%
Tags lost	217	4·4%
Totals	4,866	100%
Field 57. All Plots.		
Total flowers as shown by taggings	3,158	100%
Total sheddings due to Bollworm	352	11·1%
Total sheddings, non-Bollworm	1,871	59·2%
Total ripe bolls produced	781	24·8%
Tags lost	154	4·9%
Totals	3,158	100%

The incidence of bollworm in the new land is about the same as that of the station average over the past few years, and it is believed that the general average this season is not dissimilar. The heavier attack in Field 31 is rather interesting and appears to have been due to an eastward drift of moths from the lands which carried cotton last season. A similar tendency has been noted in the past (1941/42) and may be associated with the movement of air which takes place nightly from the rift valley escarpment towards the Lake. This, if a correct interpretation, suggests that the scatter of moths is not quite random.

Judging by our yields, bollworm control under the strictly summer crop conditions at Domira Bay Station is continuing at about the same level of efficiency from year to year, and a 10% loss of flowers (bolls) may be considered normal and inevitable.

A 2½-acre field, laid out in spacing cum time-of-planting plots of elephant grass, which has been resting under this cover for three seasons, was cleared in 1944 and planted this season to cotton. No differential treatment effects were observed and none had been expected since the cover in all plots was good and tilth throughout the field proved excellent. The cotton, a B.P.52 bulk, gave quite fair returns for the variety and season.

A pre-cultivation experiment with cotton, laid down to compare " deep digging ", " normal digging ", and " no digging ", showed significant differences in favour of " no digging " and " normal digging ". This suggests that increasing the depth of tillage is of no value in a season of good rains, while the lack of any agricultural significance for " normal digging " as compared with " no digging " makes it difficult to advise the African about digging his land as an anti-bollworm measure. For two years no old land at this station has been dug in preparation for cotton planting, and in the current season the same practice of minimum pre-cultivation is being followed.

Experience with " black cotton soil " in the newly cleared lands planted this past season confirms previous experience. The problem is to reconcile adequate surface drainage with anti-soil-erosion measures, and is being met at the station by a careful combination of surface drains, ridges and ridge terraces. Properly cultivated, the black soil of this station is the best cotton land we have.

Rotation Crops.

Pre-cultivation experiments continued this year have again failed to show significant differences between " dug " and " not dug " series of maize plots, and the same result was also demonstrated with groundnuts.

We have now had similar results with cotton, maize, and groundnuts in this " dug " and " not dug " series of experiments, and it looks as if a " normal digging " (native hand hoe to a depth of $2\frac{1}{2}$" to 3") is only necessary once in each rotation cycle ; *i.e.*, when the lands return to crop after their normal rest period under grass.

If land has carried a " hoed " crop in the previous year all that appears to be necessary in the way of pre-cultivations is clearance of detritus and remaking of ridges in preparation for the new crop.

Maize.—It has been a good year for cereals, and yields were generally high.

The new yellow selection proved significantly lower yielding than ordinary station native bulk. It will therefore be subjected to the same course of mass selection as has served us so well with the ordinary white bulk.

Maize yields in the exhaustion plots of the long term rest cropping experiment, while better than last year, were still very low, so we can be fairly certain that the plots are behaving according to plan.

Groundnuts.—Good yields were obtained with this crop and our basic seed stocks have been well maintained.

The groundnut rotation experiment was tested this season with all plots in groundnuts. No treatment differences were statistically significant, but the lowest yields occurred when groundnuts followed groundnuts directly. This is a common native practice, while that of the station is to grow groundnuts as one break only of the main rotation. Lack of rotation will not apparently lead to a crop failure, which had been feared when the experiment was begun, but it may lead to lowered yields.

Pigeon Peas.—It has been a good year for this crop, and seed from the station is in demand.

Observations in Field 44, where fertility is low, suggest that pigeon peas form an excellent " nurse " crop for elephant grass, the latter not having proved easy to establish in rather badly run-down soil. The station practice of combining the two rest crops in our main rotation is probably sound.

Elephant Grass.—There are no special notes on this crop for record. Next rainy season will see the complete establishment of the new nine-course rotational plan for the main station lands, and the 1946 dry season will see the clearing of the first break of this rotation to have four years rest under elephant grass. Two experimental fields have been cleared for testing under cotton next season. In one field, plots of elephant grass are being compared with others of elephant grass and velvet beans, in their effects on soil

fertility over a three year rest period. In the other a comparison is being made on the same basis between the effects of elephant grass, long term giant sorghum, pigeon peas, and random weeds.

Tanks and Dams.

The heavy rains gave these a good testing, and some most useful experimental results have been recorded.

Further developmental work has been done during the dry season, and we now have a single dam and a double dam series as part of the experiment. The catchment area for the single dam is rather too small and a further single dam, with catchment about equal to that of the double dam series, has been planned for 1946. Several years are needed before a pronouncement on their full possibilities can be made.

Cotton Breeding.

The new range of C.L.20 derivatives, which it is hoped contain a fair measure of Blackarm resistance, entered the multiplication plot stage this year and were compared in two small bulk trials with the best Mz.561 derivatives and certain other cottons. The latter again included our own U.4 × Cambodia × U.4 crosses, N.C.4 and N.C.7, and with these was sown a range of the same parentage from Barberton. Also included were the Malwa Upland cross with U.4, numbered A.2208, from Barberton, and B.P.52 from Uganda.

The trials occupied part of field 31, wherein tagging records were made on the Mz.561 bulk surround, but in spite of the extra hammering they received from bollworm, yields were good and the seed cotton grade quite fair. Leading places were taken by Mz.561 and C.L.20 selections, with Mz.561 bulk equal first in both trials in yield of seed cotton. T.22, the longest linted derivative from Mz.561 was also equal first. Of the C.L.20 derivatives which showed so much promise C.L.20-46 gave the second highest seed cotton yield in its trial, 809 lb. seed cotton (275 lb. lint) per acre as against 850 lb. seed cotton (263 lb. lint) per acre from Mz.561 bulk.

The Nyasaland Upland derivative B.P.52 did rather better in these trials than its bulk performance would have suggested, with a calculated yield of 610 lb. seed cotton (195 lb. lint) per acre. The Nyasaland versions of the U.4 × Cambodia × U.4 cross were close to the leaders in the yield table, but their fellows from Barberton proved rather disappointing, only one of the latter, A.250, being comparable in yield. The Malwa Upland cross, A.2208 gave the same yield as A.250.

The relatively heavy bollworm attack received by these trials may have had some selective value, and it certainly adds to the confidence felt about the cropping power of the leaders.

In general the trial results accorded with large and small scale bulk performances of the strains under test, and are thought to be reliable.

In an attempt to see whether the non-bollworm loss is in any way connected with Blackarm infestation, sprayings of spore suspensions were done using the Sudan technique (R. L. Knight). It seems fairly certain that most of our cottons are mixed for resistance. A series of re-selections has been made in the Mz.561 derivatives of plants which appeared to show resistance, and new progeny lots will be sown in plant-to-row plots next season. The results of the spraying were not entirely satisfactory, and lack of experience was felt in the field interpretation of the effects. This work will be developed further next year if favourable circumstances permit.

B.181, obtained from Uganda, was sown in an observation plot with excellent results. This cotton combines high resistance to both Blackarm and wilt and is worthy of further trial.

Selfed material, and special mass selections of Barberton " quality " crosses have been carried forward for further study.

A further large range of spinning test material has been sent to the B.C.I.R.A., Shirley Institute, containing, in addition to confirmatory lots of the Mz.561 series, a range of the new C.L.20 bulks.

With the exception of one district strain trial in the summer crop area at Sharpevale, referred to above under Agriculture, results from the districts are not yet available and cannot be dealt with in this report.

Summary of Main Conclusions.

1. Mz.561 continues to be satisfactory in its Nyasaland versions, and substrain T.22 is probably an improvement on the parent bulk. C.L.20 stocks show at least equal promise.

2. Red bollworm control at the Station has been maintained at its usual level.

3. Experiments on pre-cultivation continue to demonstrate that with land which has carried a hoed crop in the previous season such work may be reduced to a minimum.

4. Cottons which withstood in 1943/44 a year of short rains have done well under exactly the opposite conditions in 1944/45.

5. Rest cropping with elephant grass continues to prove a satisfactory practice at Domira Bay.

PROGRAMME OF EXPERIMENTS, 1945-46 SEASON.

Strain Trials.—The best Mz.561 and C.L.20 derivatives will be compared in Station and District trials, with B.181 and B.P.52 from Uganda included in some or all of the trials.

Increase Plots.—T.22 and the leading C.L.20 derivatives will be further multiplied, and both B.181 and B.P.52 planted on a field scale.

Breeding Plots.—All new selections, selfed and special bulks, of our leading cottons, and the best of the Barberton " quality " crosses will be sown.

Rotation Crops and Experiments.—All current experiments will be continued, and preparations put in train for a further series of experiments which have been planned in co-operation with the Department of Agriculture.

Part II.

There are no detailed experimental results to be recorded under this heading.

ENTOMOLOGICAL WORK
PROGRESS REPORT, 1944-45

Part I.

BY

E. O. PEARSON.

The early part of the 1944-45 season in Nyasaland was occupied principally in writing the report of which the summary is appended. At the same time skeleton routine records were maintained at Lower River Stations and further experiments were made at Makanga on the problem of obtaining earliness of the cotton crop without reducing the yield of interplanted maize. The full season's results are not available to the writer, but those obtained from the early part of the year show : (*a*) That maize planted in rows 6′ apart, with intra-row spacings of 6″ to 12″, gives only 6% less grain than the same plant populations at the spacing which is normal African practice, *i.e.*, 3′ × 4′ ; (*b*) That maize stooked 3 weeks earlier than the normal date of harvesting gave no less—indeed, slightly more—grain.

These results greatly strengthen the suggestion that by suitable, and practicable, changes in agricultural methods, competition between maize and cotton can be greatly reduced without sensibly affecting the food supply, and that therefore an early maturing crop of cotton can be obtained despite the necessity for intercropping it with maize.

From April to July the writer was travelling in the Lake Province and Eastern Province of Tanganyika, and in Portuguese East Africa, on the first of a series of tours designed to assess the status of insect pests of cotton in the principal cotton-growing countries in Africa. August and September were spent in England, where opportunity was taken to obtain information on recent developments in insecticidal methods and to make contact with other workers. October and November have been spent in travelling in Uganda, all the cotton areas of which will have been visited by the end of the year.

Part II.

Summary of a Report on the Status and Control of Insect Pests of Cotton in the Lower River Districts of Nyasaland

BY

E. O. PEARSON and B. L. MITCHELL.

(1) The Lower River is the most important area in Nyasaland for growing cotton and since 1927 this crop has been produced entirely by Africans. Since the peak year of 1935 production has fluctuated enormously, partly because of changes in the area cultivated and partly because of variations in the yield per acre. The latter, in particular, has shown an erratic downward trend, reaching in 1943 the lowest figure but one ever recorded, 94 lb. seed cotton per acre. This represents a total cash income for the year of about 15/- per grower.

(2) The fluctuations in acreage have been largely due to the loss of seasonal flood land caused by the renewal of discharge from Lake Nyasa into the Shire River, which in turn has led to a permanent rise of the river. This has necessitated a change over from a regime in which the greater part of the crop was planted on floodland to one in which the crop is exclusively raingrown on non-floodland. The situation today is thus totally different from that existing ten years ago.

(3) The downward trend in yields may be due in large part to the increased proportion of the crop which is interplanted in food crops ; this practice is primarily due to land shortage. There is no evidence to show that there has been any fall in yield or in quality which can be attributed to the seed supply.

(4) During the last five years an extensive survey of the commercial crop on the Lower River has been carried out in which crop production and crop loss, and all the possible factors connected with them, have been recorded in a number of sample areas. This has shown that the Red bollworm moth (*Diparopsis castanea* Hamps.), is directly or indirectly responsible for the destruction, in most seasons, of more than half the potential crop set by the plant. Apart from this measurable loss, Red bollworm attack also limits the size of the potential crop by causing excessive shedding of flower buds and young bolls, and in addition has the effect of shifting the time of crop

production from a favourable to an unfavourable time of year, thereby increasing the losses in yield and quality caused by drought and by diseases carried by cotton stainers (*Dysdercus* spp.). Red bollworm is thus the biggest single factor affecting the crop and is principally responsible for the serious fluctuations in yield and its low general level.

(5) Red bollworm is native to Africa and occurs naturally in association with its only two wild host plants—wild cotton and the related genus *Cienfugosia*—in two widely separated belts across the continent north and south of the equatorial zone. These wild hosts approach and at one time occupied the Lower River, but at present cultivated cotton is the only food plant of the pest occurring in the area.

(6) The larvæ feed on flower buds and bolls and when full grown enter the soil where they pupate inside a strong earthen cell. Two kinds of pupæ are found, a short-term pupa which completes its development in a few weeks and thus facilitates the rapid multiplication of the pest in the crop, and a long-term pupa which completes its development in anything from three months to a year. It is this long-term form which enables the pest to survive from one cotton season to the next. The pest is unusually free of parasites and predators and the density of population is only controlled by natural factors within very wide limits.

(7) Cotton on the Lower River is usually planted in the second half of January and is not required to be uprooted until the end of the following October, food supplies are therefore available for bollworm in greater or lesser abundance, according to moisture supplies, from March to October.

The annual cycle of bollworm activity on the Lower River starts with an infestation of the crop in March and April by moths emerging from long-term pupæ which have carried over from the previous season. Short-term generations follow each other at intervals of approximately 5 to 8 weeks, according to temperature conditions, and thus a large population is bred up in the crop, reaching its maximum in May and June. Until the middle of May practically all the pupæ formed are short-term ones, but after that an increasing proportion are long-term pupæ which will eventually give rise to the carry-over moth flight. The initial infestation occurs when the plants are entering their fruiting phase : a proportion of this early crop may survive, but the bulk of it is taken and the plant, its vigour unimpaired by having matured a full crop, continues to produce buds and bolls, on which the larvæ of successive later generations feed. These larvæ inevitably give rise to a high proportion of long-term pupæ. Later in the season, on account of the decreasing proportion of short-term pupæ formed and for other reasons, the pressure of bollworm relaxes and the plant is able to make a crop.

(8) The carry-over moth flight, partly because it is the means by which the pest survives from one season to the next, and partly because it gives rise to the initial infestation which determines the whole further pattern of crop production, is the key to the whole bollworm problem. The origin and structure of the carry-over moth flight have been analysed by the integration of records of field populations of mature larvæ with records of moth emergencies from pupæ formed by caged samples of these larvæ. This analysis shows first, that the carry-over flight is derived from the long-term fraction of the pupal population formed the previous season ; secondly, that the proportion of long-term pupæ formed increases as the season advances, March, April and early May producing almost exclusively short-term pupæ ; thirdly, that there is some mechanism by which the long-term pupæ, although originating at different times, are all induced to emerge at about the same time the following season ; fourthly, that the carry-over moth emergence is virtually complete by the end of May.

(9) Experimental work shows that the character of the pupal period is pre-determined, either in the larval stage or before. We have not succeeded in inducing the formation of long-term pupæ experimentally, although it has been shown that under the temperature conditions which obtain in the boll during the wet season only short-term pupæ will be formed, irrespective of their origin or of the nature of the food provided. Food has been shown to have no influence on the formation of long-term pupæ. A survey of all the available experimental and field evidence suggests that the formation of long-term pupæ requires temperature conditions characterised by low minima and a wide diurnal range, operating on larvæ which derive from one or more short-term generations.

(10) The intrinsic duration of the long-term pupal period is pre-determined, the individual variations in length of life representing variations in the intensity of the factor inducing the long-term condition and/or the expression of genetic variability in the response to this factor. It is impossible to " break " this condition and stimulate normal, rapid pupal development. Nevertheless, the temperature conditions under which this pupal state is passed do affect its duration, and suggest that the long-term pupa is undergoing slow physiological change throughout life, at a speed which is fundamentally pre-determined by its larval history, but which may be accelerated or retarded by the temperature at which it is kept. The average life of long-term pupæ formed at different times of the year is strikingly consistent, being at, 30° C., about 20 weeks.

(11) This being the case, long-term pupæ formed in successive months should correspondingly emerge in successive months. In the latter part of their life, however, the slow development of long-term pupæ can be inhibited by high temperatures. Such temperatures are experienced at pupation depth in the soil during the hot dry season and consequently during this time of year the development of long-term pupæ formed in May and June is completely suspended. In the

earlier part of their life, however, long-term pupæ are immune from this effect : and consequently progressively later formed pupæ are progressively less inhibited, those from October not being affected at all. In this way, the emergence of earlier formed pupæ is delayed and later formed ones are able to catch up with them : this should lead to a general, and more or less contemporaneous emergence of moths from long-term pupæ of all sources, broadly covering the months of December to April, with a peak in late February.

(12) A further complication arises here, however, in that the rising curve of emergencies is interrupted in January and February by the new factor of soil waterlogging, which causes a further suspension of emergence and prolongs the pupal period for about a month. The graph of carry-over emergences thus becomes bimodal, with a peak in December and a second, and usually much larger one, in March-April. By the end of May emergence is complete.

(13) The only control schemes which are feasible on theoretical or on economic grounds are those aimed at the weak point in the bollworm cycle, which is the carry-over from one season to the next. This can be attacked in two principal, alternative ways, (i) by permitting the minimum production of long-term pupæ, (ii) by preventing the successful carry-over of long-term pupæ. The first alternative can be achieved by limiting fruit production and hence larval production in such a way that only short-term pupæ will be formed. This means that the crop must be planted early, under conditions promoting the maximum rapidity of development, and cut out in July in order to avoid the flush of fruiting accompanying the August rise in temperature. The second alternative can be achieved by extending the close season, that is, by delaying planting, so that long-term pupæ complete their emergence and the resulting moths die before any food is available from the new crop. The very earliest planting date which could with safety be used, assuming that the uprooting date remained unchanged as the end of October, would be mid-February. This is definitely too late in the year to rely on the establishment and subsequent growth of a purely rain-grown crop. Under the present conditions on the Lower River, therefore, this alternative is ruled out.

(14) If seasonal flooding or irrigation were available, however, bollworm could be completely controlled by this method. The rainy season could be used for production of floodland rice, the pressure on the non-floodland areas would be released, allowing the establishment of a sound rotation of cereals and groundnuts with adequate rest periods, and cotton would be grown exclusively on floodland, or under irrigation, planted in April and uprooted in November. With planting delayed to this extent very little carry-over, if any, would be expected and in any case the number surviving the flooding and cultivation in the wet season would be small. The possibility of river control has been discussed in a separate memorandum : we believe that it is not impracticable and this view has recently received authoritative

confirmation. The assured success of bollworm control is demonstrated by the examples of the Karonga district in Nyasaland and the Anglo-Egyptian Sudan crop. The proposal is an ambitious one but its possibilities greatly exceed the particular objective in view and it deserves serious consideration.

(15) This is looking to the future. Under present day conditions, it is the first of the two alternatives, viz., early cropping, which offers the most promise of control. Two practical difficulties arise, the first being that a certain proportion of long-term pupæ would still continue to be formed in May-July. Studies of pupal mortality under field conditions show that the survival of long-term pupæ formed in these months is very low, due to the great length of time for which they are exposed to the attacks of predators. Such pupæ are therefore potentially less dangerous than those formed later in the year. Their survival can be reduced still further by two cultural methods : digging the field by hoe immediately after uprooting, and protecting the soil surface with a mulch of maize haulms and other plant residues. Both these have the effect of increasing the activity of predators and the latter, by reducing soil temperatures, prevents the inhibition of pupal development and thus encourages the emergence of a larger proportion of the carry-over flight before the start of the new cotton season. Both these operations are valuable in themselves as promoting and conserving soil fertility.

(16) The second practical difficulty in the way of early cropping is that over a large part of the Lower River land shortage compels the interplanting of cotton in food crops ; this delays the planting of cotton and retards its subsequent growth and rate of fruiting. The practice has spread to areas where it is not essential on the grounds of land shortage and it should be discouraged here in favour of pure stand planting. Over most of the area where intercropping is essential soils are heavy and maize is the principal food crop. Experimental work shows that the earliness of cotton is greatly affected by the date of planting of the maize : earlier planting of maize gives large increases in the yield of both the maize and the intersown cotton. Earliness and yield of cotton is similarly affected by the density and arrangement of the maize crop : very considerable improvements can be obtained by using wider spacing between the rows of maize and closer spacing in the row, at a not excessive cost in diminished maize yields. Results of experiments in 1944 suggest, in fact, that a spacing of 6 ft. between rows of maize and 6 ins. to 1 ft. between plants would give these improvements with hardly any drop in maize yields : this is now being tested. A third way of minimising the effect of maize is by a change in the method of harvesting. The usual practice of removing the cobs first and uprooting the haulms some days later means that maize continues to exert a shading effect until about 20 weeks after planting. This may be greatly reduced by various methods tested of which the most successful has been cutting and stooking the maize at 15 weeks. This gives a great increase in the early yield of cotton whilst having

no ill effect on the yield of maize. A further obvious line of attack on this problem would be breeding for short-term, short-stemmed types of maize.

(17) In the Port Herald district south of Chiromo the soils are light and the principal food crops are bulrush millet and sorghum, the former being a short-term crop which fills the gap in food supplies—usually in short supply in this area—occasioned by the lateness of the sorghum. Cotton cannot be grown below long-term sorghum and it is greatly retarded in growth when planted in millet. About a half of the cotton acreage in this area is in millet, the rest being in maize, the growth of which is usually sufficient to retard the cotton but which rarely gives a reasonable yield itself. There seems no possible way of obtaining early cropping under millet and the adoption of the suggested method of control will mean the loss of this acreage. It is worth considering the possibility of going in for pure stand cotton on the acreage now intercropped in maize : the net return would be greater and some increase in food supplies might be gained by extending mixed millet and sorghum cultivation.

(18) The greatest difficulty will be in the initial establishment of the early cropping regime in the face of the normal high carry-over from the last season of the old regime. The bollworm population could be reduced at a single blow to a level at which the suggested control measure will permanently hold it down, by the prohibition of cotton growing in the Lower River for one complete season. As cotton is the only host plant in the area, and as the emergence of moths from pupæ formed in the season has never been recorded as being delayed beyond the middle of the following year, a non-cotton year would wipe out the pest in the Lower River. Re-infestation would occur in course of time from outside areas, notably the Portuguese section of the Lower Shire valley, but by the time this happened the permanent control measures would be working. These measures may also prove acceptable to our neighbours ; reconnaissance shows that they could be used there. A non-cotton year would be a difficult and a costly undertaking, but the loss of one year's crop would probably be made up within two years by the increased yield obtained in the absence of bollworm. It must be emphasised that this is not in itself a permanent control measure. Bollworm will inevitably return to the Lower River and must be dealt with by one or other of the permanent controls suggested. The necessity for these will not be apparent in the first year : it would be possible to get away with any kind of malpractice after a non-cotton year. But the clean sweep made by such a year should give the crop every chance to become well established in the new regime, and the maintenance of this would then depend on the effort made by growers to promote early cropping and to carry out uprooting as early as possible and in no case later than July. It is therefore very important that every one connected with the cotton-growing industry on the Lower River should realise the implications of the scheme and agree to give it proper trial.

Foreword by Government on the Report.

This report has been considered by Government and it is proposed to take the following action on the recommendations contained therein :—

(*a*) To arrange for a survey to be carried out by an expert to determine the possibilities of the reclamation of floodland in the Lower River Area with a view not only to adopting the late planting method of bollworm control but more especially to increasing generally agricultural production in that area.

(*b*) If, as a result of this survey, the flood control method of Red bollworm elimination should prove impracticable, the recommendations contained in the report for a non-cotton year in the whole area should be adopted, to be followed by the introduction of early cropping of cotton and the agricultural measures ancillary to this as advocated in the Report.

[*Included by courtesy of the Nigerian Government.*]

NIGERIA.

PROGRESS REPORT ON COTTON GROWING IN THE NORTHERN PROVINCES FOR THE SEASON 1944-45

Normal Planting dates ... ... Mid-June to end of July.

Normal Picking dates ... ... December to February.

RAINFALL.

	Jan. *Inches.*	*Feb.* *Inches.*	*March.* *Inches.*	*April.* *Inches.*	*May.* *Inches.*	*June.* *Inches.*
Average (20 years)	—	0·05	0·34	1·45	5·31	6·61
1944	—	—	0·94	0·10	1·71	5·46

	July. *Inches.*	*Aug.* *Inches.*	*Sept.* *Inches.*	*Oct.* *Inches.*	*Nov.* *Inches.*	*Dec.* *Inches.*
Average (20 years)	8·72	11·70	8·71	1·44	0·04	0·01
1944	5·69	15·30	5·25	0·41	—	—

	Total. *Inches.*
Average	44·38
Range	34·86—51·84 (1927)
1944	34·86

Part I.

Introduction.

Rainfall during the year was the lowest on record. This caused a poor yield in many native farms where planting was late. On our own farms, however, we got satisfactory yields because the crop was planted in good time.

The export crop was very low, but this fact is no indication of the actual crop grown because local consumption increased enormously as a result of a fall in the quantity and quality of imported cotton goods during the war.

Cotton Seed Multiplication Scheme.

The multiplication scheme at present in use is briefly as follows :—

Stage O, at Daudawa Farm. Approximately 2 acres are sown with seed issued by the Botanist at Samaru. In recent years the Botanist has been issuing mixtures of improved strains. A pure strain, 26c, is now being issued. The seed for this stage is obtained from controlled self-pollinated flowers on the Botanist's farm.

Stage I, at Daudawa Farm. Approximately 50 acres are sown with seed from *Stage O*.

Stage II, at Daudawa. Approximately 600 acres. This area is mainly planted by settlers who work their own small farms, but are closely supervised and controlled by the Agricultural Officer at Daudawa. They are each allocated a definite acreage of cotton to grow each year and have to sell the product to the Department of Agriculture.

After *Stage II* at Daudawa the seed is issued to the cotton farmers in Awai district and in the next year the seed grown by these Awai farmers is given to others in Soba and Dutsin Wai areas and finally the seed from these last two areas is used for general distribution in Zaria Province.

Naturally with each stage of multiplication a small amount of mixing takes place, but this is kept at a minimum by the introduction of pure seed in *Stage O* each year.

Conclusions from Last Season's Work.

Two variety trials were carried out the results of which will be found in Part II of this report.

From the point of view of yield the improved strains and mixtures have done well and samples have been sent as in previous years to the Shirley Institute for spinning tests. The main point in favour of the improved strains is the increased ginning percentage.

PROGRAMME OF WORK FOR 1945-46.

As the staff is still only on a skeleton basis, no increased programme is contemplated for 1945. Variety trials will be continued to test the strains in the multiplication scheme.

Native cottons have been collected and will be grown for observation purposes and for report by the Shirley Institute.

PROGRESS REPORT—Part II.

Details of Experiments.

Variety Trial—Daudawa.

Randomised block with 8 replications and plots $\frac{1}{22}$nd acre each. Spacing was 15 in. × 2½ ft. with 2 plants per stand. Sown July 6th. No manure.

The strains were :—

(*a*) *Zaria local.* This seed was obtained from the Zaria ginnery and is now a mixture of the ordinary Commercial Allen and some of our improved strains which have been distributed in the area.

(*b*) *Funtua Local.* This is Commercial Allen seed from Funtua ginnery and contains none of the improved strains.

(*c*) *Daudawa 43.* A mixture of improved strains sown in *Stage I* of the Daudawa multiplication scheme in 1943 and in *Stage II* in 1944.

(*d*) *Daudawa 42.* The mixture used for *Stage I* in 1942 and subsequently in *Stage II* in 1943, and then given to Awai farmers in 1944.

(*e*) *Daudawa 44.* The mixture used for *Stage I* at Daudawa in 1944.

Results.

Seed Cotton.

The differences in the yields of seed cotton were not significant and were as below:—

	Lb. per acre.	*% increase over Funtua Local.*	*Ginning %.*
Zaria	545	11	30
Daudawa 43	543	11	33·3
Daudawa 44	539	10	33·3
Daudawa 42	527	8	33·3
Funtua Local	490	—	27·5

Lint.

As has been found in the past, one of the main reasons for increase in lint per acre with the selected strains is the higher ginning percentage. Thus, although Daudawa 43 only produced 11% more seed cotton than Funtua Local, it produced 34 per cent. more lint.

The experiment when analysed in terms of lint per acre was significant when P=1%.

S.E. (1 plot) was 1·14 lb. or 15% of the G.M.

Significant difference between totals P=5%=25·6 lb. per acre.
P=1%=34·5 „ „

The yields were :—

	Lb. lint per acre.	*% increase over Funtua Local.*
Daudawa 43...	181	34
Daudawa 44...	180	33
Daudawa 42...	175	30
Zaria Local	164	22
Funtua Local	135	—
Significance difference 5% =	26	
„ „ 1% =	34	

Zaria was significantly better than Funtua when P=5%.

All others were significantly better than Funtua when P=1%.

Samples of all these mixtures are being sent to Shirley Institute for reports on their spinning quality.

Variety Trial—Samaru.

Randomised block with 8 replications and plots 1/44th acre. Spacing 18 inches by 3 feet with two plants per stand. Sown June 26th. Manure 1 ton per acre F.Y.M.

The strains were :—

(*a*) 26c ; (*b*) D30 ; (*c*) Mass selected from Commercial Allen ; (*d*) D5 ; (*e*) Commercial Allen.

Results.

Seed Cotton.

The differences in yields of seed cotton were not significant and were as follows :—

	Lb. seed cotton per acre.	*Ginning %.*
26c	714	32·5
D30	698	33·3
Mass Selected	682	31·7
D5	649	30·0
Commercial Allen	626	28·6

Lint.

When analysed in terms of lint, differences were significant (P=1%). S.E. (1 plot)=0·68 lb.=14% of G.M.

Significant difference between totals (P=5%)=30·6 lb. per acre.
(P=1%)=41·3 ,, ,,

The yields were :—

	Lb. lint per acre.	*% increase over Commercial Allen.*
26c	236	32
D30	235	31
D5	206	15
Mass Selected	206	15
Commercial Allen	179	—

Significant difference 5% = 31
,, ,, 1% = 41

Varieties 26c and D30 were significantly better than Commercial Allen (P=1%).

An interesting fact about this experiment was with regard to earliness. The first picking was made on Nov. 1st which was 128 days after planting. The table below shows the percentage of the yield of each plot that was picked at the first picking.

Variety 26c.		*Commercial Allen.*	
Plot No.	*% picked at 1st picking.*	*% picked at 1st picking.*	*Plot No.*
10	31·8	21·9	14
37	32·4	32·2	39
24	38·5	23·8	33
35	50·0	20·0	7
28	34·3	25·0	23
3	29·0	25·4	1
16	29·1	23·4	26
12	24·6	29·6	20
Average	33·7%	25·2%	

Late-planted cotton is very common in the area and gives very poor yields and it is probable that the earliness of 26c compared with Commercial Allen will be an important factor.

PROGRESS REPORT ON WORK ON COTTON IN THE SOUTHERN PROVINCES FOR THE SEASON 1944-45

BY

JOHN WEST

Normal Planting dates ... ... First 3 weeks of July.

Normal Picking dates ... ... January to February.

Introduction.

The main districts growing Ishan cotton for export are confined to high and low secondary forest areas of the Guinea Zone in Abeokuta, Oyo and Ondo Provinces in South-western Nigeria, 80% coming from Oyo Province. The two ginneries are situated at Ibadan and Oshogbo on the railway.

The soils are derived from the crystalline rock formation and are fundamentally rich. Thus the bulk of the cacao crop is produced in these same areas.

The rainfall is variable, ranging from about 46 inches to 60 inches. The wet season in Oyo Province extends from April to October, with some storms in November and March. The dry season is marked, though there may be an occasional storm. The average monthly figures for Moor Plantation, Ibadan, for 1910–1944 are as follows :—

Month.	*Average Rainfall. Inches.*
January	0·52
February	0·77
March	3·67
April	5·31
May	5·95
June	7·21
July	5·87
August	3·10
September	6·85
October	6·35
November	1·78
December	0·26
Total	47·64

Cotton is sown in the month of July, some three months after the first rains begin. Between the last week in July and the end of August there is usually a break in the rains, known as the short dry season, which extends for about three weeks. June, July, September and October are normally months of comparatively heavy rainfall. Serious flowering begins during October and the flowering peak is reached from about the middle of November to early December. It is usual for severe shedding of buds and bolls to occur until the heavy rains cease.

Native Farming Practice.

Cotton is generally planted in the month of July through yams planted the previous November or March–April, and through early maize planted in March. In some cases, cowpeas may be interplanted

through cotton after the yams or early maize have been harvested. Cotton is less commonly grown as a sole crop. The following census of cotton cultivation, made in 1927–28, is probably typical of general farming practice in the South-western Provinces :—

	Meko.	*Oyo.*
Cotton through yams	40%	41%
Cotton through early maize	45%	46%
Cotton through other crops	3%	—
Cotton as a sole crop	12%	13%

Yams are planted on hills made at spacings of 4 to 6 feet, and when cotton is interplanted on the side of the hills the spacing , too, is roughly 4 to 6 feet apart. Maize is generally well on to maturity by July when the cotton is planted, so that yield is not affected, but yams may depress the cotton yield by one-third. Ishan cotton is well suited to this method of mixed cropping and this ensures the popularity of its cultivation by the farmers for export.

Yields.—When intercropped with yams the yield in native farms is about 150–200 lb. of seed cotton (50 -70 lb. of lint) per acre in normal years.

Harvesting.—The extent of a farmer's crop depends largely on the size of his family. Generally cotton is picked about three times in the season, and this is done by the wives and children of the farmer. The first picking is not done until about 50–75% of the bolls are open. Consequently a storm in January or February may considerably increase the amount of dirty lint.

History of Improved Ishan.

The indigenous native cotton of Oyo Province, *Gossypium peruvianum* had little commercial value owing to its short coarse lint. Many attempts to introduce and acclimatise American cottons failed through insect attack ; these cottons are not successful south of the Niger. In 1923 Mr. C. J. Lewin, Botanist, began selection work among the indigenous cottons, and Improved Ishan was obtained from the local cotton, *G. barbadense,* of Ishan Division in Benin Province. Improved Ishan was first distributed to farmers in 1927.

A system of pure seed supply has since been maintained, which at present is carried out by selection in the first year for lint and in the second year for yield, a system recommended by Mr. J. B. Hutchinson of the E.C.G.C. Each year a quantity of fresh seed passes from the plant breeder to the agriculturalist for multiplication.

Multiplication System.

1st year.—16 progeny rows are planted ; all plants are selfed. The best 8 rows are chosen on the basis of halo length and ginning percentage.

2nd year.—The 8 selections are planted in an 8×8 Latin Square and the best strain is chosen for the following year's 16 progeny row selection plot.

3rd year.—Remainder of seed goes to the Agricultural Officer, Moor Plantation for multiplication.

4th year.—Seed from Moor Plantation goes to Meko No. 1 area for multiplication.

5th year.—Above seed goes to Meko No. 2 for further multiplication.

6th year.—General distribution.

The Meko district, in the north of Abeokuta Province, was chosen for the two multiplication stages by native farmers because it is an isolated cotton area where full control could be exercised over the growers.

Yields.

Experiments have shown that the yield of Ishan cotton interplanted through yams is reduced by 25–35%, but that the yield is not affected when interplanted through early maize. Grown as a sole crop on Moor Plantation, Ishan has given yields ranging from 300 lb. to 800 lb. seed cotton per acre (100–270 lb. of lint), the lower figure being due to the effects of *Helopeltis* attack.

Diseases.

The principal diseases of cotton are the virus disease Leaf Curl, to which Ishan A is moderately resistant, bacterial disease (*Bacterium malvacearum*) which is troublesome in very wet years, and Anthracnose (*Alternaria macrospora*).

Pests.

In December, 1944, the Pink bollworm (*Platyedra gossypiella*, Saund.) was discovered for the first time in the three Provinces; it has since been found to be present in most of the important cotton-growing areas of the Oyo and Abeokuta Provinces. The other bollworms (*Diparopsis* and *Earias* spp.) and cotton stainers are not usually serious pests of Ishan. In some years at Ibadan, *Helopeltis sanguinens*, Popp., is a major pest.

Possibilities of Increasing Ishan Production for Export.

Ishan cotton is suited to the conditions of the high and low secondary forest of the Guinea Zone which occur in northern Abeokuta, south-eastern Oyo and central and northern Ondo and Benin Provinces. It does not do so well in the drier savannah country further north. Any extension of Ishan production would therefore seem most likely in the forest belt, but this would mean longer transport hauls to the ginneries at Ibadan, Oshogbo or Lokoja.

At present Ishan production for export has to compete with the growing demands of the local cloth industry and with the cultivation of food crops in the forest belt owing to lack of transport facilities with the savannah food-producing districts. This situation may become easier in a few years.

A possibility is the breeding of an Ishan type suited to the Middle Belt. Ishan types of seed cotton have been found in bulk samples obtained from the Lokoja ginnery, grown in some districts between Lokoja and Makurdi.

PROGRESS REPORT, 1944-45.

Part I.

Introduction.—Progeny row selection on the basis of lint qualities, halo length and ginning percentage was carried out last season for the maintenance of purity of Ishan A. Briefly, 32 progeny rows of 40 plants each were established. All plants were self-fertilized and 8 selections were made for planting the yield trial test block of next season.

Results of the 1944–45 season.—The results of lint measurements have shown no significant difference between the open and self-pollinated strains of Ishan ; this agrees with the result of the yield trial in 1943–44 which showed no significant difference in yield between the open and self-pollinated strains.

Weather conditions were favourable and the yield was fair, about 400 lb. seed cotton per acre.

Helopeltis damage was reduced by hand picking.

Damage to cotton seed by Pink bollworm was recorded during the season.

PROGRAMME FOR THE SEASON 1945-46.

The 8 selected strains made from the last season's progeny row plot will be grown next season in an 8×8 Latin Square for yield trial test.

PROGRESS REPORT—Part II.

Details of Experiments.

The rainfall in July, when the crop is planted, was actually below the average, but there were never more than four consecutive dry days, so that

the planting was done under wetter conditions than usual. The rainfall during the critical months was well distributed as is shown by the following figures :—

	1939–43.	1944.
July	5·96	4·21
August	2·52	4·12
September	6·95	6·09
October	4·92	5·35
Total	20·35	19·77

Field observations on the 32 strains showed good vegetative characters. *Helopeltis* attack was again severe, but this was combated by daily hand picking. There were also some cases of Leaf Curl which were rogued as observed. Efforts are being made to control Pink Bollworm ; it was found that about 15% of the cotton seed was destroyed this season by the pest.

Measurable characters, halo length and ginning percentage, of Ishan A for the season compare very favourably with those of the past 4 to 5 years :—

	Average. 1939–42.	*Average.* 1944–45.
Ginning percentage	31·1	35·6
Halo length	29	30·5

[*Included by courtesy of the Government of the Leeward Islands.*]

WEST INDIES.

COTTON BREEDING STATION—MONTSERRAT.

PROGRESS REPORT FOR THE YEAR 1945

AND

PROGRAMME OF EXPERIMENTS FOR THE YEAR 1946

BY

A. S. HARPER.

This season witnessed a change in the Main Breeding Trial in that the replicated progeny row system introduced in 1938 was given up for the simpler non-replicated progeny rows, as the desired characters for seed cotton are sufficiently accurately determined in the latter within the limits required for a seed maintenance scheme. The Small Bulks Trial was retained mainly as a means of checking the yielding capacity of the progenies.

Meteorology.

The total rainfall for this year recorded at the Station up to the end of November, was 65·73 inches, which is above the average annual rainfall of 60 inches. The distribution at the Station was fairly satisfactory for cotton from the time of planting, March 1st, until August 3rd when a storm passed the island, resulting in a precipitation of 8·52 inches of rain on that day. From then onwards rainfall was heavy for picking.

Cotton Breeding.

1. *Main Breeding Trial.*—This trial consisted of twenty non-replicated rows—each progeny being descended from a single plant selected from the respective 1944 progeny. It was considered advisable to retain all 1944 progenies with a satisfactory range of lint indices until more evidence was obtained on the relation between fineness and seed cotton characters, such as lint index and ginning percentage.

2. *Small Bulks Trial.*—This trial comprised ten bulks grown in eight randomised blocks. Each was obtained by bulking together similar sister progenies. The main purpose of the trial this year was to show how far last year's results are corroborated, the main indications last year being that the descendants of the family M.4204 are comparatively low yielders.

Both trials were sown on March 1st. Weather was suitable for planting and germination was good. The high winds later in March and April coupled with an attack of cotton aphis (*Aphis Gossypii*), however, considerably retarded the growth of the plants, but with heavier rains in May they recovered remarkably well. A short period of dry weather in early June was followed by heavy showers later and boll shedding occurred but was not severe. Cotton seed meal was applied to the whole area, at the rate of six hundredweights an acre, six weeks after planting.

In the Main Breeding Trial the first five flowers per plant that opened were left unselfed to provide a sample from each progeny for the determination of seed cotton characters. The flowers that opened later were selfed and selfed seed cotton was collected plant by plant. In the Small Bulks Trial picking was done plot by plot.

In the laboratory, ginning percentage, seed weight, lint index, lint per boll and lint length were determined from the sample of unselfed cotton in the progeny rows, and ginning out-turn, seed weight and lint index determined on the plots of the small bulks trial in which plot lint yields were also recorded.

Samples of lint were collected from each progeny and each bulk as well as from selected ecological areas in the Island and shipped to the Shirley Institute for hair and small-scale spinning tests. In addition, a large sample from the first multiplication area was forwarded for full-scale spinning tests.

Data for the Main Breeding Trial are given in the following table.

TABLE I.

Family	*Progeny.*	*Seed Cotton. per Boll.*	*Lint per Boll.*	*Seed Weight.*	*Ginning Out-turn.*	*Lint Index.*	*Lint Length*
		gms.	*gms.*	*gms.*	*%*	*gms.*	*gms.*
4204... ...	4501	3·84	1·10	15·13	28·65	6·08	53·6
,, ...	4502	4·02	1·13	14·84	28·10	5·80	54·2
,, ...	4503	3·54	0·98	15·17	27·70	5·81	54·6
,, ...	4504	3·69	1·03	14·85	27·90	5·75	56·2
,, ...	4505	3·75	1·08	14·84	28·80	6·00	54·6
,, ...	4506	4·10	1·20	15·31	29·30	6·34	54·8
4208... ...	4507	4·24	1·27	15·14	30·00	6·48	54·2
,, ...	4508	4·31	1·30	14·68	30·20	6·35	53·4
,, ...	4509	3·76	1·11	14·72	29·50	6·16	54·4
,, ...	4510	3·92	1·16	14·80	29·60	6·22	53·2
,, ...	4511	4·25	1·26	14·39	29·70	6·00	55·2
,, ...	4512	3·98	1·19	14·25	29·90	6·01	51·0
4210... ...	4513	3·93	1·15	14·16	29·30	5·87	54·2
,, ...	4514	3·95	1·18	14·39	29·90	6·14	54·8
,, ...	4515	3·97	1·16	13·92	29·20	5·75	53·2
,, ...	4516	3·80	1·06	14·23	27·90	5·51	54·2
4213... ...	4517	3·74	1·12	13·78	30·00	5·91	52·0
,, ...	4518	3·78	1·10	13·79	29·10	5·66	52·2
,, ...	4519	3·71	1·05	13·49	28·30	5·33	51·6
,, ...	4520	3·69	1·02	13·77	27·70	5·28	51·8
	Mean	3·899	1·133	14·483	29·038	5·923	53·67

With regard to the values obtained for seed cotton, lint per boll and seed weight there is a greater tendency towards uniformity among progenies descended from families M.4210 and M.4213 than among progenies descended from families M.4204 and M.4208. This, however,

is not the case with ginning percentage and lint index. It is also apparent that the values for nearly every character given for the progeny M.4516 are below those of the other progenies descended from the family M.4210.

Data for the Small Bulks Trial are given in the following table.

TABLE II.

Family.	*Bulk.*	*Lint. per Plot.*	*Ginning Out-turn.*	*Seed Weight.*	*Lint Index.*	*Lint per Acre.*
		ozs.	%	*gms.*	*gms.*	*lb.*
4204	4504	56·13	32·04	12·51	5·89	424·5
,, ...	4505	57·13	31·98	12·34	5·80	432·0
,, ...	4506	57·75	32·25	12·49	5·83	436·7
4208	4507	59·31	32·33	12·47	5·91	448·5
,, ...	4508	59·19	32·45	12·37	5·98	447·6
,, ...	4509	58·44	32·46	12·35	5·93	442·0
4210	4512	60·31	32·05	12·42	5·87	456·1
,, ...	4513	53·75	31·45	12·22	5·60	406·5
4213	4515	63·56	32·48	12·26	5·89	480·7
,, ...	4516	61·53	32·32	12·04	5·74	466·1
	Mean	58·72	32·18	12·34	5·84	444·1
Coefficient of Variation...	—	10·36	1·53	2·22	2·46	—
Level of Significance :						
Families	—	*	**	**	**	—
Sister progenies ...	—	N.S.	N.S.	N.S.	**	—
All progenies ...	—	N.S.	**	*	**	—

* P = 0·05. ** P = 0·01.

In the Small Bulks Trial significant differences were detected between families in every character, while between progenies belonging to the same family there were no significant differences except in the case of lint index. In lint yield descendants of family M.4213 were the highest yielders, being significantly better than those of families M.4210 and M.4204. In ginning percentage descendants of M.4208 were again highest, with descendants of family M.4213 second, both these families being significantly higher than descendants of M.4210. In lint index, however, descendants of families M.4208 and M.4204 were highest, those of family M.4208 retaining their usual position but those of M.4204 were higher than expected. Between the two bulks descended from progeny M.4210 differences were great in every character, those of bulk MB.4513 being considerably lower than those of MB.4512. This was also true of the progeny M.4516 in this year's progeny rows, one of the two progenies making up the bulk 4513. In seed weight descendants of M.4204 were highest and those of M.4213 lowest.

TABLE III.

Family.	*Lint Yield.*			*Ginning Out-turn.* %			*Seed Weight.*			*Lint Index.*		
	1943	*1944*	*1945*	*1943*	*1944*	*1945*	*1943*	*1944*	*1945*	*1943*	*1944*	*1945*
4204	47·3	39·67	57·00	31·93	31·04	32·09	14·38	13·21	12·44	6·75	5·94	5·84
4208	46·7	41·27	58·98	32·40	31·95	32·41	14·30	13·31	12·44	6·85	6·25	5·94
4210	45·2	42·33	57·04	31·23	31·38	31·75	14·12	13·34	12·32	6·41	6·11	5·74
4213	50·7	44·53	62·60	31·90	31·22	32·40	14·07	13·19	12·15	6·58	6·00	5·82
Mean	47·5	41·95	58·91	31·87	31·40	32·16	14·22	13·26	12·34	6·57	6·08	5·84

In Table III are given the yields and values for other characters of the four families M.4204, 08, 10 and 13, obtained in the Small Bulks Trial for the past three years. Bulks descended from progeny M.4213 have given the highest yields consistently. Their ginning percentage has been rather high while seed weight has remained lowest throughout the period and lint per boll and lint index values are also low. Bulks descended from progeny M.4208 have given the highest values in lint index, ginning out-turn and lint per boll regularly, but yields have only been intermediate. It appears that yield may be dependent on some other character—perhaps bolling. The bulks descended from progenies M.4204 and M.4210—both selected for low indices, the latter for low index combined with high yield—have not given consistent comparative values in yield or other characters. The descendants of M.4204 have, however, given lowest yields over the period.

Spinning Tests Results.

The results of hair tests on the 1943 material and hair and small-scale spinning tests on the 1944 material became available during the year. Ginning percentage was correlated with hair weight values for the progeny row material, the correlation coefficient obtained in the case of the 1943 material was not significant, but that for 1944 material was significant. Nanton reports that in 1939 there was evidence of a positive correlation but in 1941 the correlation coefficient calculated was non-significant, though the relationship was more marked in the case of the seven selected families in that year.

Lint index and ginning percentage were also correlated with lea count $\times$ strength product for the progeny material but the correlation coefficient was found to be non-significant in each case. for both 1943 and 1944 material. In 1941, however, strong negative correlations were observed.

The Shirley Institute reports that most of the samples gave similar values for hair weight. Differences in strength of yarn were small and in appearance too there was little to choose between most of the yarns. With regard to the commercial samples collected from selected ecological areas in 1944 differences in hair and spinning characters were also small and similar to the experimental samples.

Selection for 1946.

On the basis of yield the descendants of the low yielding family M.4204 will be discarded and those of family M.4213 will be carried on. Family M.4208 has not been superior in yield, even though ginning percentage has been consistently high, but a few progenies will be retained for further observation. Of family M.4210, M.4516 has given low value for various characters and will be discarded.

Multiplication of Selected Seed.

The seed from the 1944 progeny rows, after single plants were selected for 1945, was bulked according to sister progenies and planted

separately in the Grove multiplication strips. The seed from the Grove first multiplication was sufficient to plant over 200 acres on Richmond Estate as a second multiplication area. Growth was normal and crop good in both first and second multiplication areas. The heavy rain of August and September rendered picking and drying difficult and in consequence the viability of the seed reserved for planting has not been quite up to standard.

Distribution of Seed to Neighbouring Islands.

The usual quantities of pedigree seed were supplied to St. Kitts, Nevis and Antigua, and in addition 3,000 lb. planting seed was supplied to Nevis, 20 lb. pedigree seed to St. Lucia, and 10 lb. pedigree seed to British Honduras.

Manurial Trial on Dagenham.

An experiment was laid down in Negro House Field, Dagenham Estate, to test the advantage of (1) a quick growing green manure, in this case cowpeas, planted in November and dug under in February, that is extending throughout the close season, and (2) cotton seed meal applied at the rate of eight hundredweight an acre six weeks after sowing. The soil is of Lithosol type. Both treatments gave significantly better yields than the control—cotton seed meal giving a better yield than the green manure, but the difference was not significant. The cotton seed meal treatment was 20 per cent. better and the green manure 14 per cent. better than the control.

PROGRAMME OF EXPERIMENTS FOR 1946.

Breeding. The breeding and seed multiplication programme will be continued on the lines of the past year.

Field Experiments. It is proposed to conduct the following trials :— 1. N.P.K. trials on major soil series. 2. Comparative test with cotton seed meal and artificial fertilisers. 3. Rotational strip cropping trials.

[*Included by courtesy of the Government of the Windward Islands.*]

PROGRESS REPORT
ON THE
COTTON BREEDING WORK
AT
CAMDEN PARK EXPERIMENT STATION, ST. VINCENT,
FOR THE SEASON 1944-45

BY

W. R. E. NANTON.

General Information.

	Island Crop.	*Experiments.*
Sowing dates	1st Aug.—15th Sept.	12th Sept.
Picking dates	December—February	Mid. Jan.—end Feb.
Legal Close Season ...	May, June. July	

Introduction.

With the closing of the Empire Cotton Growing Corporation's Experiment Station in Kingstown at the end of the 1943–44 season, the continuation of the cotton breeding work devolved on the local Department of Agriculture. Simultaneous with the withdrawal of the Empire Cotton Growing Corporation's staff from the island was the establishment of the new experiment station at Camden Park, and the 1944–45 programme of experiments was conducted at this new station.

The wide scope of the agricultural research planned for Camden Park made the reduction in the volume of the cotton breeding work a *sine qua non*, and work at present is being continued on a maintenance basis, confined only to problems of immediate importance, all long-range work or work on problems of a semi-academic nature being deferred, at any rate during the period of intensive development of the new experiment station. Thus, a manurial experiment designed to test the differential responses of three superfine cottons to varying

manurial treatments, and one to investigate the interactions of the hybrid breeding material with nitrogen applications are not discussed in this report.

Weather Conditions.

No rain gauge or meteorological instrument was available at Camden Park during the greater part of the cotton season, but general remarks on weather conditions will serve to indicate the main features of the growing period. It is considered that rainfall during the vegetative phase was inadequate for proper scaffold development, a dry spell with high winds at the beginning of the calendar year terminating apical growth abruptly. This was mainly the result of late planting, for as the experiments were not established until the middle of September they did not receive the normal benefit of the August showers. Picking conditions were good, though the dry weather inhibited the development of the late bolls.

Breeding Programme.

The breeding programme may conveniently be discussed under three heads :—

1. V.135 (46) Seed Renewal Scheme.
2. VH Hybrid Breeding trial and work on other crosses.
3. Variable Bulks and Type Collection.

In all phases, the programme carried out was in accordance with the suggestions of Mr. H. L. Manning, and approved by Mr. J. B. Hutchinson, officers of the Empire Cotton Growing Corporation. The estimation of morphological and seed cotton characters and the statistical analysis of the results, however, had to be reduced to the minimum necessary for making selections, because of shortage of staff in the first instance and also because of the resignation of the Field Assistant who at that time was the only office, field or laboratory help attached to the station.

V.135 Seed Renewal Scheme.

Fourteen plants were selected in the 1943–44 season from four selected progenies to give fourteen V.135 progeny rows for observation in 1944–45. Following the established routine, these were planted as non-replicated progeny rows and self-fertilized by tying the corolla before flower opening. At picking all unselfed bolls were collected and discarded, the selfed cotton being picked later, plant by plant, and put into separate labelled bags, one for each plant.

Selection was based on yield data, due care being taken to include representatives of all the substrains. A list of the progenies selected as parents is subjoined :—

TABLE I.

Selections from V.135.				
Selected Progeny.	1943 Parent.		Strain.	Selected Plants.
	Progeny.	Plant.		
V(44)28	V(43)97	11	V(30)46	Nos. 7, 9 and 12
V(44)31	V(43)91	17	,,	,, 9, 15 ,, 16
V(44)32	V(43)85	10	V(37)11	,, 2, 17 ,, 19
V(44)35	V(43)86	3	,,	,, 4, 6 ,, 15
V(44)38	V(43)86	18	,,	,, 9, 11 ,, 18

There being no record of any off-type plant appearing in the V.135 progeny rows of 1943–44, all selfed seed remaining after selections had been made was bulked and sown at Camden Park in about two acres, which constituted the first multiplication plot. The yield of seed from this area was 1562 lb. a quantity adequate for second multiplication requirements.

The 1944–45 crop at Belvedere and Brighton planted with seed from the 1943–44 first multiplication plot yielded 20,522 lb. dry, hand-picked seed with which to establish the 1945–46 island crop.

VH Hybrid Breeding Trial and other Crosses.

An admirable conspectus of the VH breeding work over the period since its inception, and the importance of the VH hybrid material to St. Vincent has been given by Manning in a previous report. Briefly, the object is to obtain a cotton of superfine quality with a lint yield superior to that of the commercial V.135, particularly under conditions of low fertility. To achieve this, the low ginning superfine V.135 was crossed with the hardier ordinary M.S.I. variety of high ginning out-turn. Selected F_1 plants were back-crossed to M.S.I., and the progeny, known as VH (H for Heaton, the old name for M.S.I.), has been subjected to selfing and selections in the generations that followed.

The breeding material of today includes two well-defined genotypes, VH.8 and VH.10, progenies of the former approaching the superfine class as regards quality of lint, and at the same time showing an improvement on V.135 as regards yields. The genotypes differ greatly in bolling and ginning percentage, VH.10 resembling the low bolling M.S.I. parent and VH.8 the high bolling V.135. However, other factors such as lint per seed (Lint Index) and seeds per boll tend to compensate for differences in bolling so that yield differences, when measured as lint per plant or unit area, are not great between the two genotypes.

In the 1944–45 experiment nine progenies of each genotype mentioned above, together with four other VH progenies or crosses and in addition Barbados Sea Island (B.S.I.) and the parental strains V.135 and M.S.I., were compared in a 5×5 Lattice Square Experiment with three, $\frac{1}{2}(p+1)$ complete replications. The plot size was $4' \times 12'$ consisting of eight plants spaced $1\frac{1}{2}'$ apart on a $4'$ ridge.

In view of previous experience that selfing affects different progenies to differing extents, no self-fertilisation was carried out in the replicated experiment, but duplicate progeny rows of each progeny in the trial were maintained and self-fertilised to provide pure seed for future work.

Planting was carried out under somewhat unfavourable conditions on the 12th September, but by supplying with previously germinated seedlings of the same age as the main population of the experiment, a nearly perfect stand was obtained. Samples of seed cotton representative not only of the plots, but also of the whole fruiting period were drawn from each plot for the evaluation of bolling characters, but other estimates were based on the total bulk of cotton picked from each plot. A summary of the data is given in Table II.

In the analysis of variance of yield of lint, given in Table III, the sum of squares for all the progenies was partitioned to show the contributions of strains, families and progenies separately, and also to show the variation within the two main genotypes. From this it will be seen that differences in yield between strains were insignificant, the majority of the variation being due to differences within two families VH(43)10 and VH(43)46.

This indicates that there is scope for improvement in yield within both VH.8 and VH.10, but that while there are individual progenies in both groups superior to V.135 in yield, the material taken as a whole showed no improvement on the parental strains under the conditions of the experiment. It seems desirable that future tests of VH bulks should be conducted on the poorer land classes.

Differences in ginning percentage, lint index and bolling were of obvious significance between the two genotypes, VH.8. tending towards the V.135 type and VH.10 towards M.S.I. Parental values for lint length show that for this character, too, the tendency is the same. It is worthy of note that while the characters within VH.10 remain fairly constant throughout the families comprising it and even in the individual progenies, in VH.8 there exists considerable variation particularly in lint index.

In his report on the 1943–44 work, Manning was able to show by the method of multiple regression that the factor having the greatest effect on yields was not the same in the two genotypes. On the basis of his yield analysis, he suggested that in VH.8, selection for bolling might be expected to lead to the greatest improvement in lint yield whereas in VH.10, selection for lint index as well as for bolling was to be advocated. Within families these findings appeared to be generally confirmed in the trial under report, though in Family VH(43)10, the lowest boller produced the highest lint yield. Selection

for lint index in VH.10, however, is probably of little value because of the very slight variation existing in the genotype for this character.

As was to be expected, VH.9–5 was intermediate between VH.8 and VH.10 and the inter-VH crosses appeared merely to fill in the transition from the VH.8 to the VH.10 type. In RVH, a cross between VH and Red Sea Island, it was hoped to improve the VH yield by the inclusion of the strong root system typical of the red cottons. Such a cotton if it proved satisfactory to the spinner would be of particular value under low fertility conditions. From its behaviour in this trial RVH seems to justify its further trial.

Viewing the VH material as a whole and in the light of St. Vincent's requirements, it seems that there is little to be gained by continuing selection work within the VH.10 genotype. The lint lengths, seed cotton and morphological characters are typical of only ordinary Sea Island cotton and recent spinning tests indicate that the spinning behaviour of its progenies is well outside the superfine limit. The relegation of this genotype to the variable bulks collection is a matter for consideration. VH.8, on the other hand, shows some promise. The yields did not differ significantly from M.S.I. and attention has been drawn to the fact that VH(42)42, the common ancestor of the VH progenies included in this trial, produced lint within the V.135 range for spinning value. Moreover, this trial has indicated that there is considerable variation within this group of progenies and further selection seems highly justified.

Pending the arrival of the new Cotton Adviser, however, representatives of all the families were carried on in the 1945–46 material. Selection was based mainly on bolling in VH.8 and on bolling and lint index in VH.10. Single-plant selections were based on yield per plant in the duplicate progeny row.

Variable Bulks and Type Collection.

A Sea Island type collection was maintained, all the strains received from the Empire Cotton Growing Corporation's experiment station being carried on and self-fertilised. Certain of the strains were carried on, in addition, as variable bulks in which an attempt was made, merely by failure to exert selection pressure of any description, to maintain the full range of variability extant within each type. Certain modifications were made in the system of collecting selfed seed from these variable bulks to ensure that every plant grown is represented in each ensuing generation.

The type collection and variable bulks plot to a very great extent duplicate one another, and in the 1945–46 season, the two are being amalgamated, all types being carried on as variable bulks in which plants regarded as typical of their strains can be recognised and segregated if necessary.

TABLE II.

SUMMARY OF DATA—MAIN VH BREEDING TRIAL

Strain.	Family.	Progeny.	Lint per plot. Total.	Ginning Out-Turn.	Seed Weight.	Lint Index.	Bolling Index.	Lint Length.
			gm.	%	gm.	gm.	arb'y.	m.m.
RVH	RVH(43)74	RVH(44) 1	185	31·3	15·0	6·68	255	59·4
	VH(43)10	VH(44) 2	199	28·5	13·2	5·24	340	59·5
		,, 3	251	28·4	13·5	5·36	421	59·8
		,, 4	162	28·2	14·3	5·41	298	58·8
		Mean —	204	28·4	13·7	5·34	353	59·4
VH8	VH(43) 7	VH(44) 5	200	27·1	13·3	4·94	368	58·6
		,, 6	170	24·2	13·2	4·18	350	58·8
		,, 7	208	25·8	13·9	4·83	391	58·0
		Mean —	192	25·7	13·5	4·65	370	58·5
	VH(43) 9	VH(44) 8	191	26·1	13·4	4·73	333	56·2
		,, 9	200	25·7	12·5	4·33	358	57·8
		,, 10	180	25·9	13·2	4·62	362	57·2
		Mean —	190	25·9	13·0	4·56	351	57·1
Mean	—	—	196	26·7	13·4	4·85	357	58·3
VH.9–5	VH(43)25	VH(44)11	175	28·5	14·0	5·59	283	58·0
	VH(43)46	VH(44)12	150	32·5	14·2	6·86	173	53·8
		,, 13	169	30·5	14·5	6·39	210	53·2
		,, 14	181	31·9	13·9	6·50	222	52·4
		,, 15	238	31·7	13·7	6·35	292	54·6
		Mean —	184	31·7	14·1	6·53	224	53·5
VH.10	VH(43)47	VH(44)16	218	31·2	14·6	6·61	265	54·0
		,, 17	189	32·2	14·1	6·71	209	53·6
		,, 18	180	32·2	13·6	6·47	226	54·4
		,, 19	194	31·6	14·3	6·63	233	55·0
		,, 20	179	31·6	14·5	6·71	221	56·0
		Mean —	192	31·8	14·2	6·63	231	54·6
Mean	—	—	189	31·7	14·2	6·58	228	54·1
VH.8×9	VH(43)61	VH(44)21	164	26·4	13·5	4·87	273	57·2
VH.8×9×10	VH(43)73	VH(44)22	167	28·5	13·9	5·53	246	57·4
B.S.I.	B(43)78	B(44)23	184	27·4	11·8	4·45	410	53·8
M.S.I.	M(43)77	M(44)24	193	32·9	13·8	6·76	228	55·2
V.135	V(43)97	V(44)25	190	24·5	12·9	4·21	387	61·6

P= ± 36·4 gm.

TABLE III.

ANALYSIS OF VARIANCE OF YIELD OF LINT PER PLOT IN THE MAIN VH BREEDING TRIAL

Due to	Degrees of Freedom.	Sum of Squares.	Main Square.
Squares	2	2,321·6	1,160·8
Rows—eliminating treatments	12	10,658·7	888·2
Columns—eliminating treatments	12	34,320·6	2,860·0
Progenies—ignoring rows and columns :			
Between Strains	8	5,240·7	655·1
,, VH.8 families	2	941·0	470·5
,, VH.10 families	1	343·9	343·9
Within Family 10...	2	11,994·0	5,997·0
,, ,, 7...	2	2,392·7	1,196·4
,, ,, 9...	2	622·9	311·5
,, ,, 46...	3	12,521·6	4,173·9
,, ,, 47...	4	2,887·6	721·9
Error	24	31,845·8	1,326·9
TOTAL	74	116,091·1	

Coeff. of Variation=19·7%

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37 Inner Park Road, Wimbledon Common, London, S.W.19

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